POWER PLANT ENGINEERING

Trade-mark reg. U. S. Pat. Office

SEMI-MONTHLY

VOL. XXI. CHICAGO, SEPTEMBER 15, 1917 No. 18

Meeting Increased Demands

TWELVE-MILLION GALLON PUMPING UNIT ADDED TO STATION EQUIPMENT OF SHEBOYGAN, WIS., WATER WORKS; DIRECT-TO-MAIN SERVICE EMPLOYED

MUNICIPAL OWNERSHIP of public utilities, which in many instances has been found impracticable from both financial and engineering standpoints, is today in many instances proving successful. A study of conditions resulting in failure of community ownership and operation of electric light, power and water plants will, in the majority of cases, reveal inefficient management and many times unscrupulous tactics so frequently employed by politicians. On the other hand, however, we find that where public utilities have been acquired and are being operated with politics entirely eliminated, results have been most gratifying and in many cases rates to the consumer have been materially reduced. Such has been the experience of the City of Sheboygan, Wis., where, since the local water works system was purchased in 1909 from the American Water Works & Guaranty Co., it has been found possible not only to make the plant self-sustaining after having twice reduced the rates, but to show a considerable profit at the end of each fiscal year. In fact, so successful has been this enterprise, it is said, that improvements and extensions to the plant and system have required no bonded indebtedness whatever.

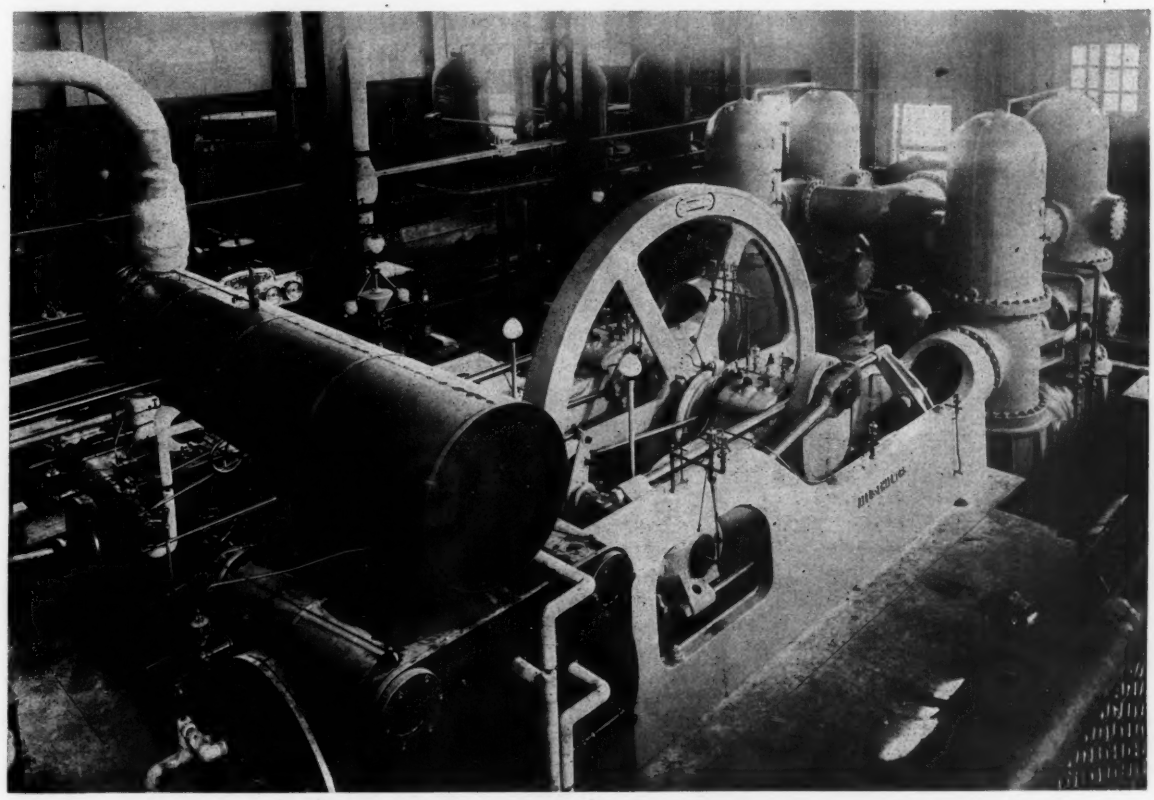


FIG. 1. INTERIOR VIEW OF PUMP HOUSE WITH NEW UNIT IN FOREGROUND

Increase in cost of fuel, supplies and labor experienced in recent years make the results obtained of considerable significance. The reason for this can be attributed only to efficient and careful management on the part of those in charge, especially at the plant, the heart of the system.

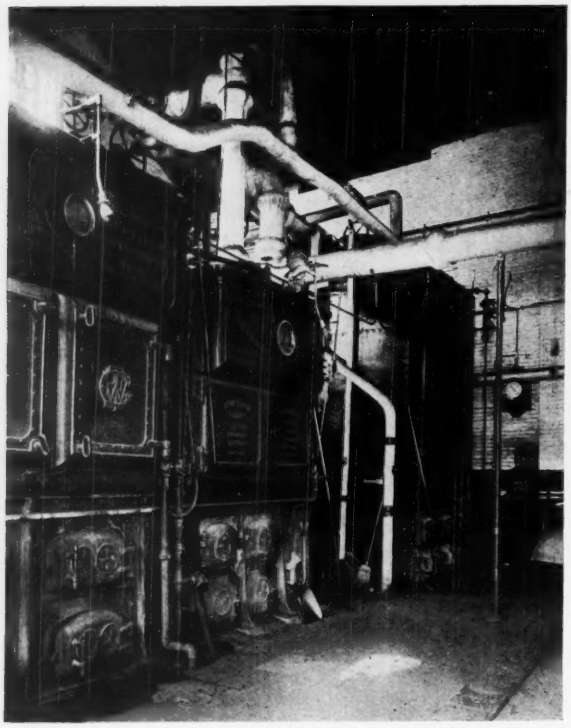


FIG. 2. BOILER ROOM OF SHEBOYGAN WATER WORKS PLANT

Increased needs of the city for domestic and industrial supply and fire protection have resulted in an increased average pumpage of from 2,734,500 gal. per day in 1910 to an average of 3,526,000 gal. each 24 hr. in 1914; in 1916 the maximum output for any one day was 7,700,000 gal., while the minimum daily output was 3,500,000 gal. Realizing the consequence proportionate future increases in demand would have upon the station equipment, the commission in charge of the system, with the consent and approval of the city council, made provision for extensions to the plant and installation of additional equipment of such capacity as to meet the needs of the city for some time to come. These improvements have been just completed, and as a result, considering size, the station now ranks among the first along the Great Lakes.

Steam-Generating Equipment

In the boiler room, which is now practically a new structure of steel and concrete built to conform with the architecture of the rest of the building, is the steam-generating equipment consisting of 3 boilers. One of these is a 300-hp. Hawkes unit, while the other two each rated at 150 hp., are of Heine and Geary make respectively. The first two mentioned are equipped with Coppus turbo blowers by means of which it is possible to carry considerable overload during periods of heavy demands.

Coal is delivered to the plant by trucks and discharged into an 800-ton storage bin from where it is taken as needed and brought to the boilers by means of ¾-ton cars run on an industrial railway. From these cars it is fired by hand into the boiler furnaces, and to facilitate operation, the Hawkes furnace has been equipped with Cyclone shaking grates, while the Heine is equipped with Shearclean grates.

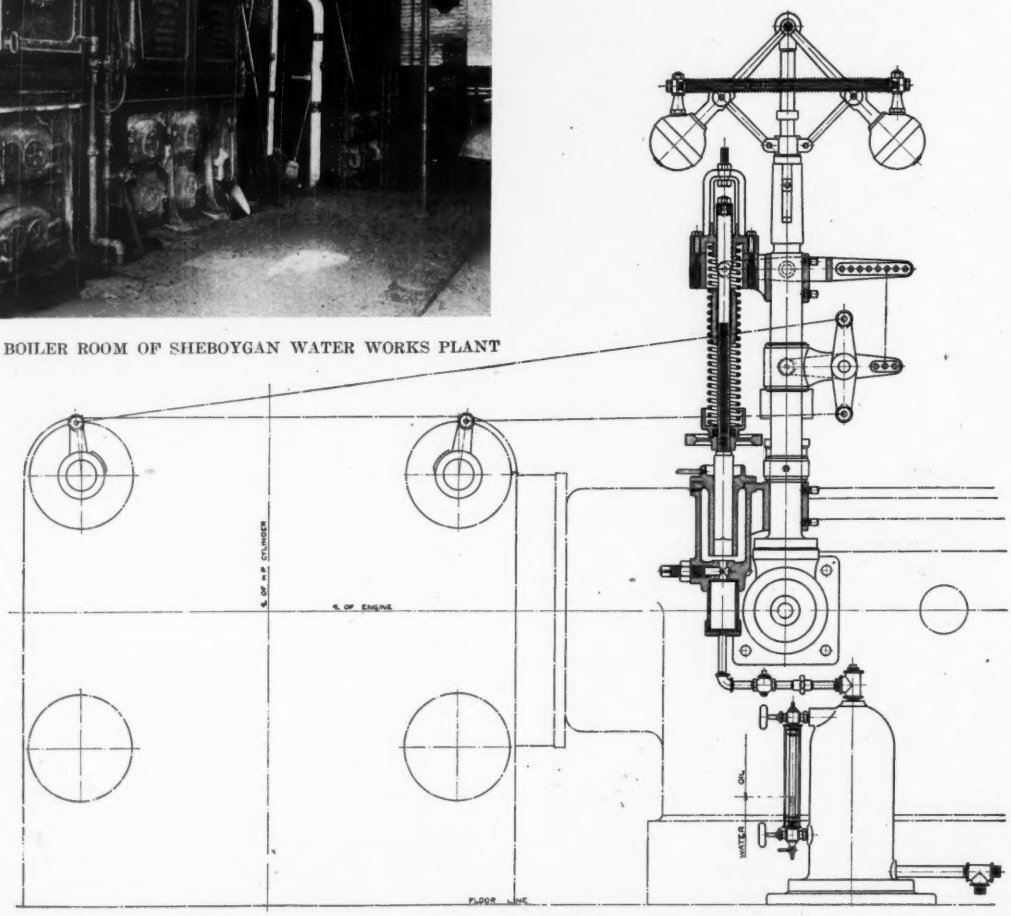


FIG. 3. ARRANGEMENT OF HYDRAULIC REGULATOR AND GOVERNOR

Water used for boiler feed purposes consists for the greater part of condensate taken from the surface condensers operating in conjunction with the main engines and is pumped through a closed feed-water heater into the boilers by means of plunger pumps attached to and operated by the rocker shafts of the engines. For emergency and for feeding during such periods as when the engines may be shut down, a 6 by 4 by 6-in. Buffalo duplex pump has been installed in the boiler room.

At any time should more water be delivered by the engine-operated pumps than is required by the boilers, the surplus is discharged into the sewers by means of a bypass in the main feed line provided for the purpose.

Steam which is generated at pressures ranging from 110 to 140 lb. gage, depending upon the size and number of units in use and the load being carried, is delivered by the boilers to an 8-in. header from where it is distributed to the various units through 6-in. branches.

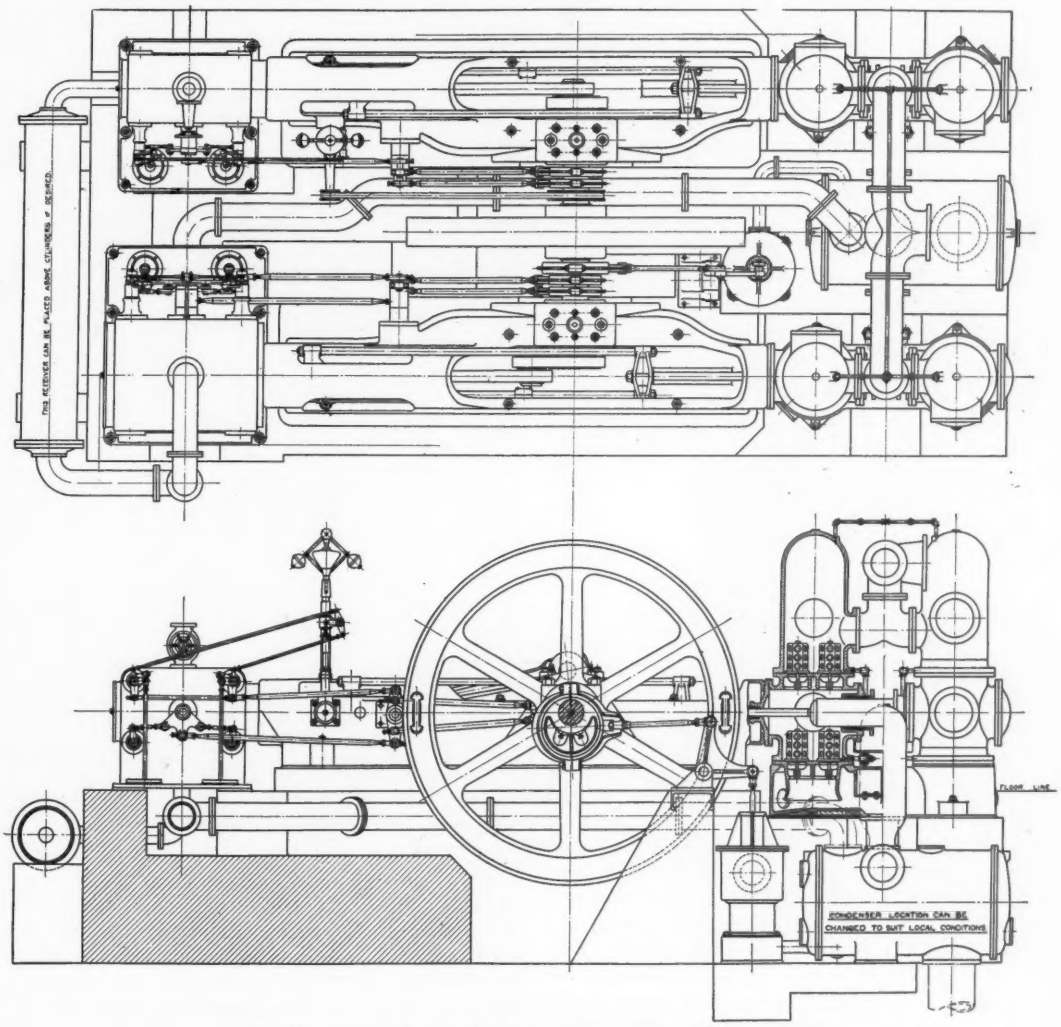


FIG. 4. GENERAL ARRANGEMENT OF NEW PUMPING UNIT

Pumping Units

Water may be taken from Lake Michigan through any one of three intakes, one of which is, however, practically abandoned. The main and most recently laid intake consists of a submerged, stone-filled, timber crib, 5000 ft. from shore; from it a 30-in., cast-iron pipe laid 5 ft. below the bottom of the lake, with 46 ft. of water over its upturned, screened end, extends to a 55,000-gal. brick pump-well located just outside of the pumping station. The second intake which is considered and operated as a reserve, consists of 1850 ft. of 20-in. pipe, partly trenched and extending from a submerged, stone-filled, timber crib with 28 ft. of water over it, to the pump well.

Up to the present time, the pumping equipment consisted of one horizontal, tandem compound noncondensing duplex-acting Gordon unit having 18½ and 29-in. steam cylinders, 16½-in. plungers and 18-in. stroke; one horizontal, compound flywheel type condensing, duplex double-acting Holly pumping engine with 16 and 32-in. steam cylinders, 17½-in. plungers and 28-in. stroke, and one horizontal, cross compound flywheel type condensing, duplex double-acting Nordberg unit, the steam cylinders of which are 25 and 46½ in. respectively, the plungers 15½ in. and the stroke 48 in. The rated daily capacity of these units is 3,000,000, 4,000,000 and 8,000,000 gal., respectively, or a total of 15,000,000 gal.

Increasing demands have, however, necessitated the installation of an additional pump which has just been placed in operation. This set, which is of Allis-Chalmers make, is designed for a working steam pressure of 140 lb. per sq. in., and is capable of delivering 12,000,000 gal. a day against a normal head of 196 ft. and a maximum head of 300 ft. for fire pressure conditions. No tests have as yet been conducted, but according to the manufacturers' guarantee, the engine of this set should develop no less than 143,000,000 ft. lb. of work for each 1000 lb. of steam consumed.

Shown in Fig. 4 are plan and elevation of this unit. It is of the opposed type generally accepted as the standard owing to the economy in space and to the rigidity obtainable due to the arrangement of the main frames, which form a solid tie between the steam cylinders on one end and the water cylinders on the other. This arrangement also prevents the introduction of any strains due to alternate heating and cooling of the steam cylinders.

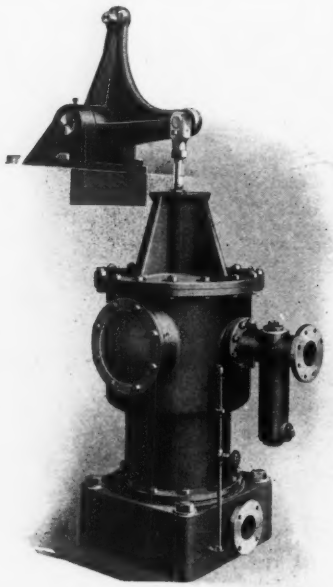


FIG. 5. AIR PUMP AND DRIVE USED IN CONNECTION WITH NEW PUMPING UNIT

Both high and low-pressure cylinders, which have diameters of 24 and 52 in. respectively and a stroke of 42 in., and are equipped with Corliss valve gears, are steam jacketed, and in order to avoid any possibility of leakage of steam from the jacket into the cylinder, they are cast in one piece. Any tendency of the cylinder walls to cool, due to the comparatively low temperature of the exhaust steam, is prevented by the exhaust passages being separated from the cylinder walls by the jacket space.

The governor is equipped with a hand adjustable mechanism for varying the speed of the engine throughout a considerable range while the engine is in operation and, as the service in this installation is direct to the mains, a hydraulic pressure regulator is provided by means of which the discharge pressure acts directly on the steam admission valve gear of the high-pressure cylinder, making it possible to maintain the discharge pressure at a predetermined point within narrow limits. Ordinarily an average pressure of 80 lb. is maintained, which, however, in case of fire or other emergency is raised to about 120 lb.

There are two pumps of the double-acting type with outside center-packed plungers, each located directly in line with its corresponding steam cylinder.

Removable cast-iron cages are mounted on the valve decks of the water ends so as to secure an easy and direct flow of water through the pump. Each valve cage is securely fastened to the valve deck by means of a bronze bolt extending entirely through the center of the valve cage and threading into the deck. The faces of the valve decks are machined to receive the valve cages, which are provided with bronze valve seats, each of which has a central stem, fitted with brass spring, guard and check nut. The valves are composition rubber discs.

Suction and discharge lines of all the pumps are so interconnected and valved that any or all of the units may be operated simultaneously, and as is the general practice in water works installations, surface condensers are inserted in the main suction lines of the pumping units. And in order to afford an easy flow of water, the condensers are arranged for the passage of the water through the condenser shells around the outside of the tubes.

In the new unit, the air pump is of the vertical single-acting bucket type driven through the medium of a bell crank from an eccentric on the engine shaft. Condenser and air pump are so located that all condensed steam is drained by gravity from the condenser to the suction of the air pump.

Pump discharge connections are fitted with spring-loaded bypass valves to care for any excess pressure which, due to some cause or other, might be created.

House Lighting

THE STATION depends upon its own source of supply entirely for light, a 3-kw. Allis-Chalmers direct-current generator, direct connected to a 5 by 5-in. automatic engine of the American Blower Co. make, having been recently installed for the purpose.

CARRYING OUT the suggestion of the Government that water transportation be used, as far as possible, to assist the over-burdened railroads, Keystone Steel & Wire Co., of Peoria, Ill., has recently shipped 1200 tons of pig iron from Sheffield, Ala., to Peoria, using the Tennessee, Ohio, Mississippi and Illinois rivers for a distance of about 681 miles. In shipping this load from Woodward, Ala., to Sheffield on the Tennessee river, 33 cars were used; and in the water transportation, 3 barges, towed by a steamer which left Sheffield on July 21 and arrived at Peoria, Aug. 1, without accident and with no delays except a slight one caused by a shallow lock at Copperas Creek, where part of the load had to be transferred to a fourth barge. Dredging will take place at this point, to do away with this impediment. The trip was presumably a success financially as well as mechanically, as the company is making plans for further transportation in the same way.

NOTHING SUCCEEDS like the financial success some men make of a failure.—Ideal Power.

TO START a gas engine in cold weather, use about four parts gasoline to two of ether. Prime the engine with this mixture. Then crank it over once, and it will go every time.—Gas Power.

Stirling Boiler Construction

RAPID CIRCULATION, LONG TRAVEL OF FLUE GASES AND ADAPTABILITY TO VARIOUS FORMS OF FUEL ARE INCLUDED IN ITS ADVANTAGES

ALTHOUGH built differently to meet varying conditions of floor space and head room, all classes of Stirling boilers have the same general design, varying in depth, height, and in the number and length of tubes according to the horsepower rating.

As shown in Fig. 1, the boiler consists of 3 transverse steam-and-water drums, set parallel, and connected to a mud drum by water tubes, so curved as to enter the tube sheets radially. The steam space of the center drum is interconnected to both the front and rear drums by a row of curved steam circulating tubes and the water spaces of the center and front drums are joined by water circulating tubes, the number of these

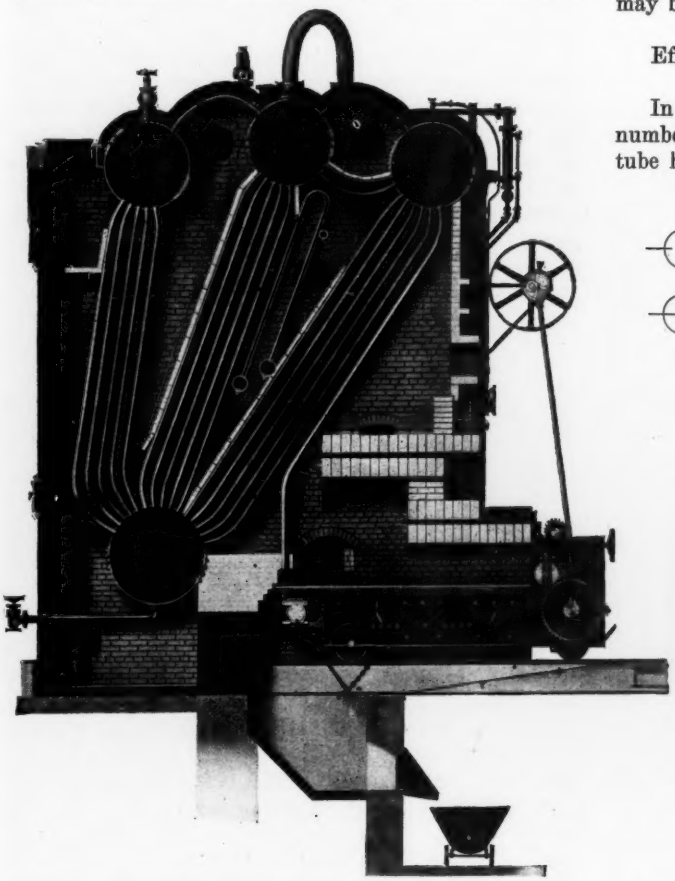


FIG. 1. ELEVATION OF STIRLING BOILER WITH SUPERHEATER AND CHAIN GRATE STOKER

water tubes depending upon the class of boiler. Each drum is made of a single tube sheet riveted by a butt and strap longitudinal seam to a drum sheet, one head of each drum being provided with a manhole.

Upper drums are supported by saddles which rest on a structural steel framework, and the mud drum is suspended from all the upper drums by the water tubes, swinging entirely clear of the setting brickwork. Blowoff connections are placed at the bottom of the mud drum and are extended through a sleeve in the rear or side wall. Air leakage around the ends of this drum is prevented by soft asbestos packing between it and the brickwork. This construction, together with the curvature of the tubes, gives ample provision for expansion and contraction.

Tubes are expanded into reamed seats and alternate tubes entering the upper drums are beaded to increase their holding power. All tubes entering the mud drum are beaded to prevent the existence of air pockets.

LIGAMENT EFFICIENCY

TO DETERMINE the efficiency of a ligament between the tube holes of a Stirling boiler, the following formula may be employed:

$$\text{Efficiency of ligament} = \frac{p - nd}{p}$$

In which p = unit length of ligament in inches; n = number of tube holes in length p, and d = diameter of tube holes in inches.

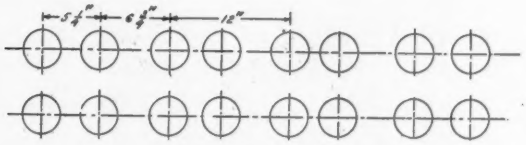


FIG. 3. TUBE SHEET LIGAMENT

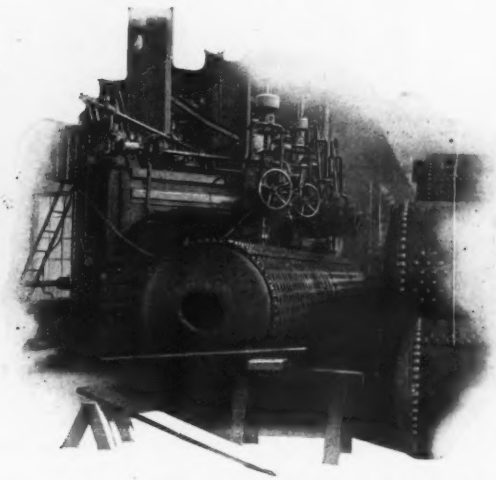


FIG. 2. DRILLING TUBE HOLES IN STIRLING BOILER

Example:

With spacing as shown in Fig. 3 and diameter of tube holes = 3 9/32 or 3.281 in.:

$$\text{Efficiency of ligament} = \frac{12 - 2 \times 3.281}{12} = 0.453$$

In case it is necessary to change a boiler tube, this can be done by using an inside cutter to cut the pipe at both ends, and as the distance between each row of tubes is slightly greater than the diameter of the tube, it can be easily withdrawn. It is then passed through

one of the doors built into the setting for that purpose. By cutting a slot with a chisel in the two tube ends that are left and crimping them, these ends are easily removed from the drums.

Combustion is favorably influenced in the Stirling boiler by the high space over the grate, which with the fire arch, serves as an excellent heat storage chamber, and insures perfect combustion before the flue gases come into contact with the cooling surface of the tubes.

Any size of grate can be installed in this boiler, the ratio between the heating surface and the grate can be carried at from 1 to 50, to 1 to 20. Any kind of fuel, from high grade anthracite to the lowest grade of lignite, or slack, can be burned with satisfactory results, if proper grates and furnace proportions are used.

Efficiency of the boiler is not affected by accumulation of a quantity of ashes, especially from the lower grade of coal, as the ashes cannot pile up on the tubes, due to

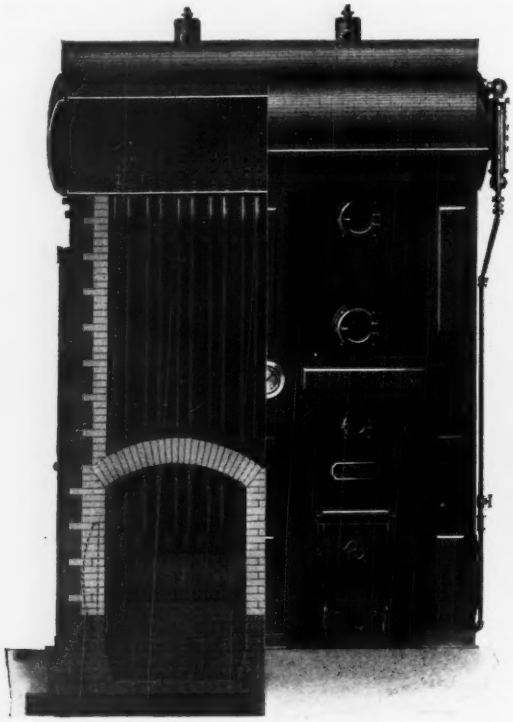


FIG. 4. FRONT AND SECTIONAL ELEVATIONS THROUGH FURNACE AND FRONT STEAM DRUM

their vertical position. For this reason, the gases from coke and zinc ovens, which carry a large proportion of ashes, may be used in connection with Stirling boilers.

Baffle Construction

Baffle walls guide the gases up the front bank of tubes, down the middle bank, and up the rear bank. Baffle openings are so designed that there will be a proper distribution of the gases with a minimum amount of throttling action, and can be adjusted to suit fuel conditions.

Baffles are formed of ordinary fire brick tile and rest against the rear tubes of the first and second banks, reaching in the first instance from the mud drum nearly to the top of the first bank, and in the second instance from the center steam-and-water drum nearly to the bottom of the second bank.

This last baffle is supported by rods extending to the steam circulating tubes as shown in Fig. 1. In setting baffle tile, care should be exercised to have the joints occur directly behind the tubes. To prevent the gases from passing above the water circulating tubes between the front and middle steam-and -water drums, a covering of fire bricks is provided.

In designs which do not include a superheater, a shelf is placed near the top of the front baffle to deflect the gases into the second bank of tubes, and a second shelf is placed near the rear bank of tubes to deflect the gases and prevent bypassing between the tubes and the rear wall. When a superheater is provided, the first shelf is omitted and a short baffle is placed between the superheater and middle drum.

Circulation of Boiler Water

Feed water enters the rear upper drum and discharges into a removable trough by which the water is distributed over a relatively large width of the drum. As the drum temperature is never higher than the steam temperature, the scale forming substances precipitate as a flaky mud, which can be drawn off through the blowoff valve. After being relieved of most of its scale, the

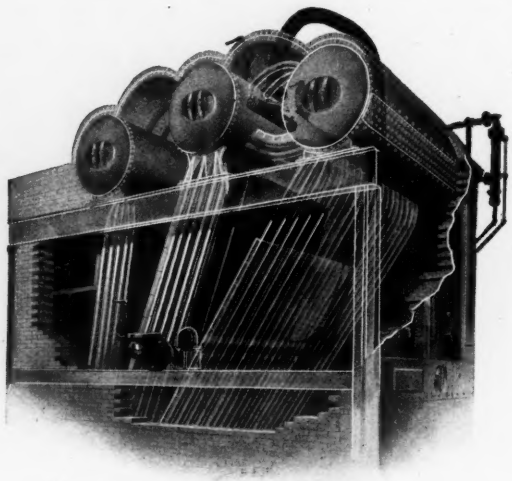


FIG. 5. B. & W. SUPERHEATER INSTALLED IN STIRLING BOILER

feed water slowly descends the rear bank of tubes, which, being vertical, do not permit an accumulation of scale on the tube walls. Passing through the tubes, the feed water becomes further heated and precipitates the remainder of the scale when passing through the lower drum. The low velocity of the water, and change of flow before entering the other banks of tubes, causes the scale or mud to separate out and accumulate in the mud drum.

Free from scale, the water passes upward through the front bank of tubes to the forward steam-and-water drum and thence through the lower circulating tubes into the middle drum. It then flows downward through the middle bank to the mud drum, from which it again passes up the front bank to retrace its course.

On account of the rapid generation of steam in the first bank of tubes, the water level in the front drum is agitated, and is generally known to be higher than in the middle drum. If steam were taken from the front drum, it would be moist, especially if the load on the boiler is subject to quick changes or is extremely high.

Steam formed during the passage through the front bank of tubes becomes separated from the water in the front drum and passes through the upper row of cross tubes into the middle drum, from which it passes through a dry pipe into the steam main. Steam generated in the rear bank of tubes passes through the rear steam circulators into the middle drum. Two independent safety valves are placed on the top of this drum.

If superheated steam is desired, the superheater is installed in front of the second bank of tubes as shown in Fig. 1. In Fig. 5 are shown the location, method of support, and method of making inlet and outlet connections for a B. & W. superheater as installed in a Stirling boiler.

Care and Management of Stirling Boiler

Before placing a new boiler in service, a thorough examination should be made of the pressure parts. The setting should be inspected to see that the baffle openings and the distance from the arch to the tubes are as called for by the installation drawings; that the mud drum and blowoff pipe are free to expand without interference with the setting walls; and that all brick and mortar are cleaned from the setting and pressure parts. Tie rods should be set up snug and then slacked slightly until the setting has been thoroughly warmed by the first firing. Internally the boiler should be examined to insure the absence of dirt, waste, oil and tools.

Firing the boiler with green walls will invariably crack the setting brickwork unless it be properly dried. To start this drying process, the damper and ash pit doors should be blocked open to maintain a circulation of air through the setting. Whenever possible, this should be done for several days before firing. When ready for firing, wood should be used for a light fire, gradually building it up until the walls are thoroughly warmed. Coal should then be fired and the boiler placed in regular service.

If a boiler is to remain idle for a period not to exceed 3 mo., it may be filled with water while out of service. The boiler should be thoroughly cleaned, internally and externally, all soot and ashes being removed from the setting and any accumulation of scale removed from the interior surfaces. It should then be filled with water to which about 4 buckets of soda ash have been added, a very light fire is started to drive the air from the water, and after the fire is allowed to die out, the boiler is pumped full.

If the boiler is to be out of service for more than 3 mo., it should be emptied, cleaned and thoroughly dried. A tray of quicklime should be placed in each drum, the boiler closed up, the grates covered and a quantity of quicklime placed on them. Special care should be taken to prevent air, steam or water leaks into the setting or onto the pressure parts, to eliminate the danger of corrosion.

Elimination of Corrosion in Hot Water Supply Pipe*

Results Obtained by the Removal and Fixation of Oxygen and Carbon Dioxide. By F. N. Speller

FREE oxygen and carbonic acid in water have been proved to be the cause of practically all the trouble with hot water supply lines, as these gases are retained in the water with the closed systems of heating used almost universally in this country. Two methods of removing these gases are: (1) by reducing the pressure of the heated water—for example, by the use of an efficient "open" type heater under atmospheric pressure, or partial vacuum; or (2) by keeping the hot water in contact with a large surface of iron under pressure for a sufficient length of time to remove and "fix" the oxygen and carbon dioxide.

The latter principle has been in use at two plants during the past year; at the Research Laboratory and Hospital Building, National Tube Co., McKeesport, Pa., and at the Irene Kaufmann Settlement, Pittsburgh, Pa. Both installations have demonstrated that the corrosion of iron or steel pipe can be arrested and practically eliminated by this process.

The Irene Kaufmann Settlement was built in 1910, using wrought iron and steel pipe for the hot and cold water lines with storage tanks and gas heaters, one branch of the system supplied the pool and showers and another the residence and laundry. All the hot water piping was showing signs of serious corrosion by 1915, a number of pieces having already been replaced with brass pipe. Every week or two replacements and repairs had to be made.

With the approval of the Directors, we installed experimentally a new hot-water heating system, to supply the residence and laundry alone, which was put into use, December, 1915. This consisted of a storage tank filled with alternate pieces of corrugated and plain steel sheets, No. 26 gage, arranged radially around a filter as shown in Fig. 1. The water was heated by a No. 2-D Stewart heater (3 gal. per minute) and passed downward between these places, being thereby deoxidized to a large extent. The water then flowed upward through pipes to the top of the filter and downward again through the filter and finally up through the central pipe to the system. The return with check was brought into the bottom of the chamber underneath the filter bed.

It is, of course, necessary to filter the fine rust out of water so treated before use, and it is also necessary that the filter be so designed in connection with the heater as to be kept hot when no water is being drawn. Figure 2 shows these three elements separate but connected together so as to perform their various functions as installed at our plant at McKeesport, Pa. The latter is apparently the more economical and practical form of construction although one plant works just as well as the other, except that neither one was provided with a heater of sufficient size to maintain the temperature of the water up to maximum at all times. This is important

*From a paper read before The American Society of Heating and Ventilating Engineers.

inasmuch as the speed of deoxidation varies with the temperature.

The course of the water circulating between the heater and storage tank is shown in Fig. 2. By this arrangement the temperature of the filter is maintained the same as the water in storage. Where circulation of hot water has to be maintained in the buildings, the outlet line can be taken up through the filter bed and the return connected in at the bottom of the filter. If required a small auxiliary heater can be placed under the filter, with the inlet connected to the return.

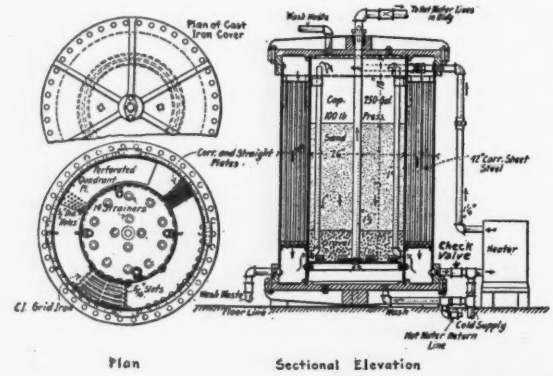


FIG. 1. PLANT FOR DEOXIDATION OF HOT WATER AT IRENE KAUFMANN SETTLEMENT, PITTSBURGH, PA.

In this plant discs of "Cambridge" metal lath were used although strips of this or other suitable form of sheet iron may be used provided it is spaced so as to fill the chamber and yet leave a cellular structure with openings not over ¼ or ⅜ in. through which the water can freely circulate.

The average daily consumption of treated hot water in the system at Irene Kaufmann Settlement varies from 600 to 1200 gal. In the other system in this institution using untreated water somewhat less is used. The normal temperature of the hot water is 170 deg. F.

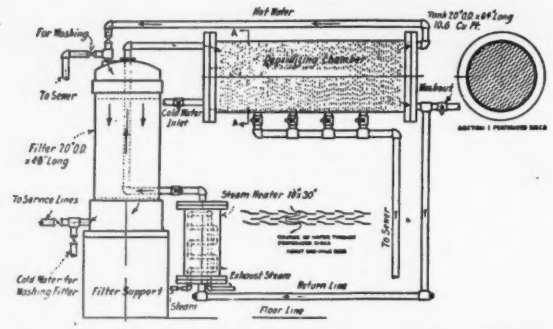


FIG. 2. PLANT FOR DEOXIDATION OF HOT WATER AT NATIONAL TUBE CO. WORKS, MC KEESPORT, PA.

The average oxygen contents of the water before treatment at the Irene Kaufmann Settlement was about 8 c.c. per liter and after treatment 0.5 c.c. per liter.

The original piping in this building was about worn out at the time the present system was installed; in fact, this was the main reason for selecting this location for these experiments. Since that time (for nearly a year) they have had no trouble with the old piping. Once rust starts, the action is usually accelerated, so that the arresting of corrosion in these old pipes is of great significance and promise.

At the time these changes were made in December, 1915, the Pittsburgh Testing Laboratory was asked to obtain and install material for a corrosion test in these lines to be run simultaneously with the water treating test and to observe the results of this system of water treatment on the piping. This was carried out under the supervision of Jas. O. Handy, Director of Laboratories. The relative corrosion of pieces taken from the same length of pipe, with and without treatment, as shown in his report (Fig. 3) indicates the results obtained by eliminating this amount of oxygen from the water. The pipes carrying deoxidized water were in use a month longer and carried 50 per cent more water but show from 62 to 85 per cent less corrosion, based on the deepest pitting in the pipe carrying untreated water. The best results were found with the steel pipe marked "N. C.", which had the least amount of mill scale on the inside surface. Incidentally the material selected by the Pittsburgh Testing Laboratory for test with water heated in the regular way affords another comparative service test bearing out the conclusions based on previous tests of this kind; viz., that there is no practical dif-

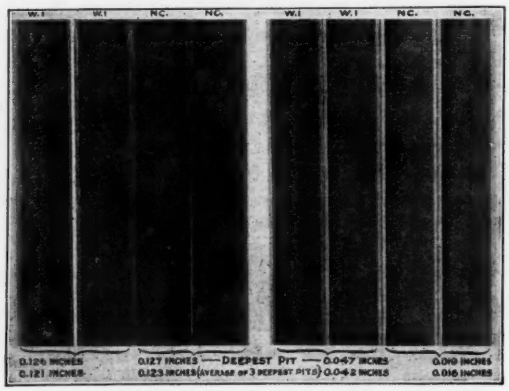


FIG. 3. COMPARISON OF PIPES OPERATING WITHOUT AND WITH THE USE OF THE DEOXIDIZER

ference between the best grades of so called "genuine" wrought iron and steel pipe under these conditions.

These experiments also indicated that water, which has been in contact with the plates in the deoxidizer, still carried considerable gas in solution, but that this gas consisted mainly of hydrogen and nitrogen. The hydrogen frequently ran as high as 20 per cent. The oxygen in untreated water frequently runs as high as 26 to 30 per cent of the volume of dissolved gases.

It is also of practical interest to note from gas analyses and oxygen determinations made from time to time, that the rate of removal of oxygen has not diminished with length of service. Plates which were removed from the McKeesport plant after 8 mo. service had a thick layer of rust over the surface, but the efficiency of the tank was even greater after use. Except with water carrying organic matter and clay in suspension we would expect this to be the case.

Assuming the raw water contains 9 c.c. of free oxygen per liter and is completely deoxidized, from the analysis of the rust formed, about 220 lb. of iron will be used up

in treating 1,000,000 gal. of water. At this rate and figuring the cost of sheet iron scrap at 2c per pound, the cost of material for deoxidation of water is well within the usual cost of chemicals for the treatment of boiler water.

Lost, a Damper

AN IMPOSSIBLE THING THAT ACTUALLY HAPPENED

SOMETIMES things get mislaid; that is, they are not put back where they are usually kept. And again, in some plants, not yours, of course, things are so seldom put back in place that they haven't any place, and nobody thinks of looking where they belong, but anybody who wants a tool goes around asking everybody whether he has seen it or had it.

But in this case, the damper was not in place where it belonged; nobody had used or seen it or mislaid it; yet it was lost, and made a lot of trouble before it was found.

The plant had been shut down for some time because the last owner made an error in his cost system and before he found it the sheriff had charge. Then the slump of early 1914 came along, and nobody seemed to want to make anything in that particular factory until a big war order set things booming in the town.

Every factory that had a power plant was needed, so the engine was overhauled, the boiler inspected, pumps repacked and all the rest cleaned and wiped and inspected and tightened and adjusted to the pink of condition for a long run under high pressure.

Fires were started and all seemed going well until the load came on and the engine called for heavy steaming. Then the pressure began dropping, and in spite of all coaxing the boilers wouldn't pull.

There was plenty of capacity, good coal, a big chimney, dampers open in the breechings, surfaces clean—but no steam. It looked like no draft, but a U tube at the base of the stack showed plenty. And there was some fussing and unpolished language distributed around that plant, while the boss and the super and a hundred or so hands offered suggestions, with the usual percentage of sense in them.

Finally the chief, who was a new man in the town, but level headed, yelled, wildly but with certainty and conviction: "You'd all better clear out. I think the boiler's going to blow up." And the crowd didn't stop to see that the pressure was 60 lb. on a boiler allowed to carry 125, but acted on the suggestion.

"Well," said the chief to the fireman, as soon as the room was clear, "where there's a result there's a cause. Things don't 'just happen' in a power plant as they do in a factory. So we got to find the cause. She's got plenty of draft in the stack, but what becomes of it? Look at that big uptake. Can't be any trouble there."

No leaks of any consequence were found in the setting. There were no holes in the breechings and the clean-out door at the base of the chimney was tight.

So they started trying combinations. Any one of the three boilers would pull well, but one wouldn't carry the load. When two were on, they did fairly; but with three on, the fires went dead and burned like green cordwood.

"Evidently not enough draft, but look at that draft gage," said the chief.

"Yes, but how about the draft in the breeching?" suggested the fireman.

So they drilled a hole and tried it. Nothing doing! The stack reading showed 1.5 in.; the breeching with that one boiler on showed 1.25 in., and with three boilers on, 0.5 in.

"Well, what in thunder is between those boilers and that stack?" was the chief's comment. "Anyway we'll soon find out." And the fires were heavily banked with ashes, dampers closed, stack clean-out door opened and the chimney allowed to cool down.

Then the chief climbed up inside the chimney to the uptake connection and started down. And there was the Lost Damper. A big butterfly in the main uptake, nearly closed and the journal broken off just inside the uptake so that it couldn't be seen from the outside.

Whether the bell crank and journal end had been broken off during the shut down, or the damper had formerly been wedged open and had jarred shut during the overhauling, nobody could find out. And why a damper was ever put there never got explained. But it didn't take many hours to cut it loose and drop it in the bottom of the chimney. And that ended that trouble.

"Next time a thing don't work," said the Chief, "I'll know enough to look for the most impossible trouble in a place where it can't possibly be."

The Engineering Council

WAR conditions have brought out impressively the need of united, co-operative action among engineering societies and, as a result, The Engineering Council has been formed. Four societies have taken the initiative in this work in order to pave the way for a union of local societies, national societies and engineers who are not members of any society. Committees have been appointed on Public Affairs, Messrs. C. W. Baker, G. F. Swain, S. J. Jennings, E. W. Rice; on Rules, Messrs. J. P. Channing, Clemens Herschel, N. A. Carle, D. S. Jacobus; on Finance, Messrs. B. B. Thayer, I. E. Moultrop, Calvert Townley, A. C. Humphreys.

To invite the co-operation of all engineering societies, the American Engineering Service Committee has been appointed, Messrs. A. D. Flinn of the Civil Engineers, A. S. McAllister of the Electrical Engineers, G. J. Foran of the Mechanical Engineers, G. C. Stone of the Mining Engineers and E. B. Sturgis of the Mining and Metallurgical Engineers. Its present duty is the listing of the members of these five societies and eventually of all engineers in the United States so that the information may be available for any need. The immediate purpose is to procure men for special services required by the Government.

In making up this list, the help is needed of all national and local societies as well as individual engineers, and information should be given to A. S. McAllister, secretary of the committee, 29 West 39th St., New York City.

Present officers of The Engineering Council are Ira N. Hollis, chairman, Geo. F. Swain, vice-chairman, H. W. Buck, vice-chairman, Calvert Formley, secretary.

Oil and Powdered Coal as Fuels*

CONSTITUENTS, METHODS OF BURNING, PRECAUTIONS IN FURNACE DESIGN. BY JOSEPH HARRINGTON

AS THE situation exists today, crude or fuel oil forms almost the only fuel in use for heating the small industrial furnace. This fuel has been developed in its application to a high degree of refinement.

As it comes from the ground, as the so-called crude oil, it contains the entire series of hydrocarbon compounds, although not always in the same proportions. Western oils are as a rule richer in the heavier constituents, while those from Pennsylvania contain more of the lighter or more volatile elements. Another broad division as to character is determined by the nature of the residuum left when all the volatiles are removed. Certain oils, when subjected to complete distillation, leave an asphaltic substance, and others a paraffin. These so-called "bases" seem to be the body or element binding the parts together and determining the "weight" of the oil. The words "heavy" and "light" are terms indicating in a general way the proportion of base in the oil being described. This base, being in solution in the lighter and more fluid parts, affects the density or specific gravity to a marked degree. Since the base is a combustible hydrocarbon, it follows that an increase in density increases the number of heat units in a given volume, the gallon being the volumetric unit commonly used in the oil trade.

Following this line of reasoning, it would seem that of two oils offered for sale, one weighing 7 lb. and the other 7½ lb. per gallon, the latter would contain the greater number of heat units. This is actually the case, the purchaser getting about seven per cent more heat in each gallon.

There is a practical limit, however, to the extent to which one can apply this reasoning. As the density of the oil increases, the fluidity decreases, and difficulties are encountered in pipe lines and nozzles. Increased temperature will offset to a large degree the tendency toward viscosity, and care must be taken, if heavy oils are to be burned, to provide adequate heating facilities, both at the tank and along the pipe lines.

At the burner also increased air pressure must be provided, or difficulty will be had in properly atomizing the oil. The necessity for complete atomization increases as the density of the oil increases, since the natural volatility is becoming less. This is a function of the "oil burner," which is strictly a misnomer when applied, as it so often is, to the nozzle or injector. The combustion chamber really deserves this name if any one part of the combination is to be so called.

An astonishing number and variety of oil feeding devices have been devised and built, and the subject of injecting oil fuel into a furnace for combustion purposes has been the subject of the most elaborate and extensive experimentation. It is therefore today a highly developed branch of combustion engineering, so that it is relatively definitely defined in its methods and results. Oil is a more uniform fuel than coal, and it is a most interesting thing to note that the heat value per pound is about the same, whatever kind or density is taken. Crude oil varies from 18,500 to 20,000 B. t. u. per pound, and if the constituent parts are tested the same range of heat values are obtained. Accurate heat determination is more difficult than with coal, and similar samples will apparently show as much as 500 or 600 B. t. u. difference.

On the whole, however, the fluid fuel can be fed to a furnace with considerable uniformity, air supply can be nicely regulated and combustion efficiency secured and maintained.

There are two general principles upon which oil feeding is based, and these will be described in order.

The first method is one which depends upon the heat of the furnace and its incandescent brickwork to volatilize the oil and put it in shape for rapid combustion. This in a sense is a gasification of the oil from the bulk state. Oil is injected into a furnace of high temperature, and a rapid absorption of heat causes the liquid to vaporize and rise to the ignition temperature. In this state it becomes highly inflammable and burns with an intense heat. If the furnace, however, is not in suitable condition for the quick volatilization of the liquid, the combustion is delayed and heat is developed beyond the point where it is most desired.

The essential weakness of this method lies in its dependency on the furnace heat for volatilization of the oil. There are two variables here to contend with; first, the volatility of the oil itself and, second, the furnace temperature. Both may and do vary. Another defect of this method is the fact that if too high pressures are used for the furnace served, some of the oil may actually reach the distant wall in liquid state, and by adhering thereto, become carbonized and partially lost. Not only may this be the case, but the temperature may be so intense from the blowpipe action of the oil jet, that destruction to the brickwork may result. A final variable is the changes in oil or air pressures.

The second method is the mechanical vaporization of the oil by means of a spray head or nozzle arranged in such a manner that the oil is of necessity divided into very fine particles or globules. In this condition the amount of exposed surface relative to the volume of oil becomes greatly increased, and oxidation may proceed with the utmost rapidity and completeness. This system differentiates very sharply between the gasification or volatilization of the liquid by virtue of a highly perfected mechanical subdivision. It is obvious that a liquid may be so finely divided that it will remain in suspension an appreciable time, like a cloud of steam. This is what is commonly observed in the case of water with lawn sprinklers or cooling nozzles for spray cooling.

If this process is effected by means of compressed air, it can be accomplished with about 20 per cent of the air required for the complete oxidation of the fuel. A basic fact must not be overlooked in this connection: The very idea of mechanical atomization carries with it the thought of a diffusion of spray in a volume of air, and the surrounding of each globule with an atmosphere of air. It is an easy step, therefore, both in one's mental conception of this condition, and in the actual furnace, to

*From a paper read before the International Railway Fuel Association.

add and intimately mix more air to the now gaseous fuel. If this air is injected by mechanical means in such a manner as to blend rapidly with the cloud of oil spray, the flame takes on the character of the Bunsen burner flame, the mixture being perfect and the temperatures exceedingly high. It is quite possible, however, to induce the balance of the air requirements through adjustable ports or openings surrounding the spray nozzle. When the oil spray, with its portion of carrying air, is given a swirling or spiral motion, it has a decided tendency to disperse under the action of centrifugal force, largely losing its axial velocity. Under these conditions it is noted that the combustion takes place right up to the tip of the burner and melting temperatures may be obtained within 6 or 8 in.

An important means of judging the temperature of a flame is by its color or luminosity. The luminous element is the carbon particles heated to incandescence just before being burned or oxidized. Aside from the fact that such particles are a part of the flame and that they are an index of the flame temperature, contributing their share of heat thereto, they have no exclusive monopoly of the temperature control, and are not a necessary adjunct to high gaseous temperatures.

The Bunsen burner produces an almost invisible flame, yet high temperatures may be developed. A proper atomization of fuel oil and commingling with the right amount of air will produce the elements of perfect combustion. The flame will be short and intensely hot, and will not fill the furnace with a great luminosity, yet the furnace temperature may be much higher than when full of flame. This is the principle underlying the Billow system.

Much has been said in regard to the destructiveness of the oil flame at close quarters, and efforts have been unceasing to find a refractory substance which is able to withstand the high temperatures developed. One of the fundamental principles of furnace design is that the temperature is directly affected by the proximity of the furnace walls and roof.

At the present time, and probably for some years to come, all refinements in the selection or purchase of fuel oil must be forgotten. Users are fortunate in being able to get anything that will burn, and prices are several times those of a year or so ago. The tremendous demand for motor fuels and the ever-increasing requirements of certain special industrial processes tax the country's output to the limit and render a consideration of other fuels timely and appropriate.

Powdered Coal

Engineers have recently become much interested in the use of powdered coal as a fuel for furnaces. Fulfilling as it does the requirements of a gaseous fuel, it combines the possibility of high efficiency with a cost indicative of great economy.

It is unnecessary to give the specifications for pulverized coal, but I would like to emphasize the fact that in certain classes of service an extra fine grind repays the trouble and expense of obtaining it. Coarse coal results in offsetting substantially all of the fundamental advantages of pulverized coal, and too great care cannot be given to this item.

It is entirely possible to adapt this fuel to any size of furnace. It is a fuel of such a nature that intelligent care must be expended on the furnace design and application thereto. There is nothing in the nature of this fuel to prevent its successful use on any scale whatsoever. Powdered coal nozzles or so-called burners are being made, scarcely an inch in diameter. Those required for the larger furnaces may run up to 18 in. in diameter. The pressure of the air required for its introduction must be carefully controlled and adapted to the particular service. Ordinarily the pressure should be as low as possible, and dust introduced in a slow rolling cloud, widely diffused.

On account of the independent control of both fuel and air, it is readily possible to obtain any gas analysis that may be desired. I show a tabulation which illustrates some actual gas analyses taken by the writer in an annealing oven. The air in this case was held at a constant volume, and the amount of coal varied by means of the speed control in use at this plant. This was a variable speed motor with a 10-point rheostat. When the maximum CO_2 was reached, CO began to develop because of the limitation to combustion imposed by the size of the furnace. If coal had been introduced in still further amount, CO would have amounted to a considerable percentage, and the CO_2 would have been appreciably reduced. We would then have had almost a gas producer effect, under which condition the furnace temperature would have rapidly declined.

Gas Analyses

Air Supply Constant		Coal Supply Constant	
Rheostat Point No.	CO_2 at Flue	Air Gate Notch No.	CO_2 at Flue
1	13.1	1 (open)	13.0
2	14.0	2	14.0
3	14.1	3	14.5
4	15.9	4	15.7
5	16.3	5	16.7
6	16.8		
7	17.1		
8	17.1 (smoky flame)		

The question of furnace temperatures enters into this consideration just as it does in the case of oil. It is quite as possible to melt out an entire interior of a furnace with powdered coal, and economy of fuel and floor space almost always dictate the furnace design. In a given furnace the temperature rises as the excess of air is cut off, and this may be so great as to be destructive. At the same time, however, it must not be forgotten that reduction of excess air may be carried to the limit without excessive temperatures, if the furnace proportions bear the correct relation to the amount of coal fed per unit of time. In the furnace from which the gas analyses above quoted were taken, the temperature was maintained constant at 1500 deg. F., and at the same time between 17 and 18 per cent of CO_2 was developed. This furnace, however, had about 200 cu. ft. of cubical contents per pound of coal per minute. If this had been 10 cu. ft. with the same amount of coal per minute, temperatures would have been developed which would have melted the brickwork rapidly.

I quote these two figures because they happen to be actual cases wherein temperatures were observed. Intermediate temperatures would have been obtained with volumes between the two limits stated. It is therefore a possibility that high combustion efficiency can be ob-

tained without the production of destructive temperatures.

Powdered coal really takes on the character of gas when diffused throughout a current of air. Its finely divided condition permits it to be carried in suspension for an almost indefinite time, provided the velocity of the carrying current is maintained. It is quite possible, therefore, to supply a series of widely separated furnaces with this fuel by means of a pipe line, much the same as would be the case with a directly gaseous fuel. The advocates of powdered coal call attention particularly to the marked advantage this fuel has over oil as to cost. With a 12,000 B.t.u. coal at $2 a ton and a fuel oil at 3½ c. a gallon, 1 c. will purchase 3.2 times as much heat in the form of coal as in the form of oil. While no reference has been made in this paper to natural gas as a fuel, it is interesting to include it in a tabulation design to illustrate the relation between the amount of heat purchasable with 1 c. and the amount purchasable in the form of oil and coal. In this case prices existing at the present time are used, and a fairly good grade of Pittsburgh coal is considered.

COMPARATIVE PURCHASING POWER OF ONE CENT

Oil—	
B.t.u. per lb	19,000
Weight per gal	7 lb.
B.t.u. per gal	133,000
Cost per gal	5 c.
B.t.u. for 1 cent	26,600
Gas—	
B.t.u. per cu. ft	960
B.t.u. per 1000 cu. ft	960,000
Cost per 1000 cu. ft	25 c.
B.t.u. for 1 cent	38,400
Coal—	
B.t.u. per lb	14,000
B.t.u. per ton	28,000,000
Cost per ton	$3.00
B.t.u. for 1 cent	93,333

Ratios—

1 cent will buy 1.44 times more heat in gas than oil.
1 cent will buy 3.54 times more heat in coal than oil.
1 cent will buy 2.43 times more heat in coal than gas.
Coal can be sold for $10.62 per ton and equal oil at 5 c. per gallon.
Coal can be sold for $7.29 per ton and equal gas at 25 c. per 1000 cu. ft.
Oil would have to be bought for 1.4 c. per gal. to equal coal at $3 per ton.
Gas would have to be bought for 10.7c per 1000 cu. ft. to equal coal at $3 per ton.

A rather marked difference is noticed in favor of the coal, which goes far in paying for the initial cost of the pulverizing plant. The cost of coal preparation per ton has been given by Mr. Robinson. I shall briefly quote the tables showing these figures:

Capacity of Plant in Short Tons per Hour	Average Total Cost for Preparation per Short Ton
2	from 25 to 50 c.
3	from 20 to 45 c.
4	from 16 to 40 c.
5	from 14 to 35 c.
10	from 12 to 30 c.
25	from 10 to 20 c.

The fuel required for drying the coal will average from 1 to 2 per cent of the coal dried.

The distribution of the total cost may be approximately stated as:

Fuel for drying	10 per cent
Power for operation	30 per cent
Labor	30 per cent
Maintenance and supplies	25 per cent
Interest, taxes, insurance and depreciation	5 per cent
Total	100 per cent

One of the matters most frequently mentioned in connection with this fuel is the disposal of the ash and its effect on the surrounding brickwork. The effect and control of the ash is a topic of sufficient magnitude to form the subject matter of an extended article in itself; and no attempt will be herein made to analyze this subject in detail. In the steam boiler the effect of ash is probably more difficult of control than in the metallurgical furnace, because, as a rule, the ash dust reaching the hearth is not in sufficient quantity to affect operation seriously.

IN THE PROVINCE of Ontario, Canada, the Hydro-Electric Commission is selling electrical energy at cost to municipalities, the price being adjusted from year to year. Some 5,000,000 hp. is available, and of this, 702,000 hp. has been developed. It is reducing coal consumption to an extent of 4,500,000 tons a year, a saving of about $20,000,000.

The eastern part of the territory is now receiving attention, and a line has been run by the Cedar Rapids Power Co., 45 miles in length, to carry about 100,000 hp., from Cedar Rapids on the St. Lawrence river, 30 miles east of Cornwall, through Cornwall to Massena, N. Y., and a step-down transformer station is now being constructed at Cornwall to reduce from 110,000 volts to 26,000 volts. The Cedar Rapids Co. pays from $11 to $15 per horsepower to the Hydro-Electric Commission, and with the step-down and transmission charges added, this will make the price in the vicinity of Cornwall about $24 per horsepower per year, the price being decreased in proportion as the amount of horsepower used increases.

IN LOANING MONEY to the United States Government by purchasing Liberty Loan Bonds, the capital of the country is not being depleted. The money paid in for bonds is deposited in the banks, and comes back to the people of the country in the purchase of equipment, supplies and munitions for the use of the departments of the United States Government and the Allies, so that the net result is, that the United States will owe to its people the amount of money loaned, but the people themselves will get back this money in payment for the materials purchased. To repay the loan, part of the money will, of course, be collected in the form of taxes from the people in the United States, and part from the people of the foreign governments to whom loans are made. There will be waste of wealth because of the destruction of property in war, but this will not impair the capital of the people of this country.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

The Station Testing Laboratory

TYPICAL COST FIGURES INDICATE ADVISABILITY OF SUCH AN INSTALLATION. BY JOHN D. MORGAN

THE power station testing laboratory has in the past few years become one of the most important departments of power generation, due to the fact that it is a necessary factor in the economic operation of such stations. Ever growing installation and operating costs make it essential that all power plants operate at a maximum point of efficiency, such maximum point being limited by the design efficiency.

Cost of installing a testing laboratory is perhaps of minor importance to one acquainted with the results accomplished; but to the majority of men who control expenditures this is the all important point and their first views in regard to the installation of a testing laboratory are that its installation cost is too great. Suppose we analyze the laboratory installation costs in comparison to the station installation cost. For example, assume the plant to have a capacity of 75,000 kw. and 30,000 boiler horsepower complete with all modern improvements and

Electrical & Mechanical Testing Instruments	$8610.16	or, 36.23%	of total cost
Chemical & Coal Testing Equipment	3157.16	or, 13.29%	" "
Mechanical Testing Equipment	3099.96	or, 13.04%	" "
Switchboard Testing Table	1903.63	or, 8.03%	" "
Tools & Miscellaneous	1811.05	or, 7.63%	" "
High Tension Testing Equipment	1770.50	or, 7.45%	" "
Storage Batteries and Fixtures	1368.89	or, 5.44%	" "
Photometric Apparatus & Equipment	1200.57	or, 5.05%	" "
Photographic Apparatus & Equipment	777.97	or, 3.28%	" "
Books	150.40	or, 0.63%	" "
Total	$23750.50		

TABLE I. STATION TESTING LABORATORY COSTS

with this assumption in mind, the actual installation costs of such a station would be about as follows:

Building	$1,046,516
Turbines, etc.	1,243,139
Boilers and stokers	736,093
Piping	227,860
Switchboards	140,000
Misc. equipment	919,392
Total cost	$4,313,000

Now, it is possible to equip a laboratory complete for all necessary and research work for the sum of about $24,000, or about 0.56 of 1 per cent of the station cost. The subdivision of costs for such a laboratory would be about as shown in Table I.

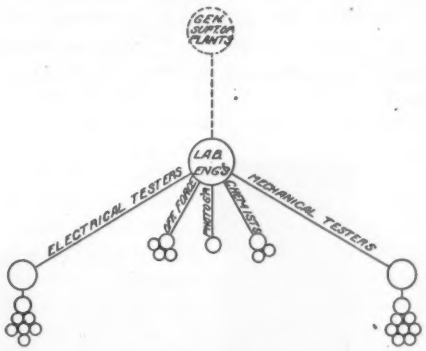
It also should be remembered that such a laboratory equipment could not only be used in connection with the station work, but could also be employed by the distribution, commercial and engineering departments at large, and as the system grows the proportion of money invested in the laboratory will grow smaller.

In the study of the duties of a testing laboratory, it might be well first of all to consider the organization chart of the laboratory force. This can best be done by the graphical method and for such a laboratory as we have in mind the chart would be about as shown herewith. From this it will be seen that a force of 26 men is

Capital Charge of 6% on $24,000	= a yearly charge of	$ 1,440.00
Depreciation, Expected Life being 10 yr.	= " " "	1,918.96
Salary Account	= " " "	21,000.00
Operating Supplies, etc.	= " " "	7,500.00
Total Operating Cost per Year	= " " "	$31,859.96

TABLE II. PROBABLE OPERATING EXPENSE OF LABORATORY

required with a yearly payroll of about $21,000. There seems to be a general feeling that the laboratory is part of the engineering department, but it has been found that where such is the case the operating department maintains a smaller laboratory resulting in friction and additional expense; hence, since the greater amount of work done by the laboratory force is for the operating departments, its scope of work should be directed by them.



TYPICAL LABORATORY ORGANIZATION CHART

It is impossible to enumerate all the duties of a laboratory, but in general its most essential ones are as follows: Making acceptance tests of all new equipment; testing meter standards used by meter department; testing all rubber goods used for electrical protection; testing of insulators and other line material; testing of all materials bought under specifications; photographing all apparatus and special features; making daily coal

tests; analyzing feed water, circulating water, etc.; compounding all chemicals used; making periodic tests of all electrical and mechanical instruments and gages; making tests on lamps, etc.; making special operating tests; study and report on special features and methods used by other companies.

The results accomplished cannot all be determined on a financial basis, yet it is possible to show that a large financial saving may be realized. In order to get a true idea of the saving, we must first of all consider the total operating expenses of the laboratory which may be as in Table II.

Now assuming the net output of the plant to be 267,500,000 kw.-hr. which would be equal to a station capacity factor of 40 per cent, the coal rate would be about 2.35, the net thermal efficiency about 10.4 per cent; these facts would give a total operating cost of about $1,337,500 for the year and assuming the coal cost is about 80 per cent of the total cost, then the coal cost for the year would be about $1,070,000 thus showing that a saving of only 3 per cent in the total coal cost would equal the total laboratory charges for the year.

Again, let us take for example, the testing of meter standards. If by careful testing the standard can be made 0.1 of 1 per cent more accurate, a saving of 267,500 kw.-hr. would be made in the amount of current accounted for and since in the majority of meters a lag is more prevalent, we can assume that this would equal at 10c per kilowatt-hour, an additional revenue of $26,750 or 2/3 of the laboratory yearly charge.

Then again by the testing of rubber gloves, linemen's belts, etc., a life may be saved and there is no one who can place an adequate value on a life saved.

In a like manner, each and every duty performed by the testing laboratory can be analyzed and all will show a material saving. Therefore, under proper supervision, the testing laboratory can be made to be the best dividend payer on the property.

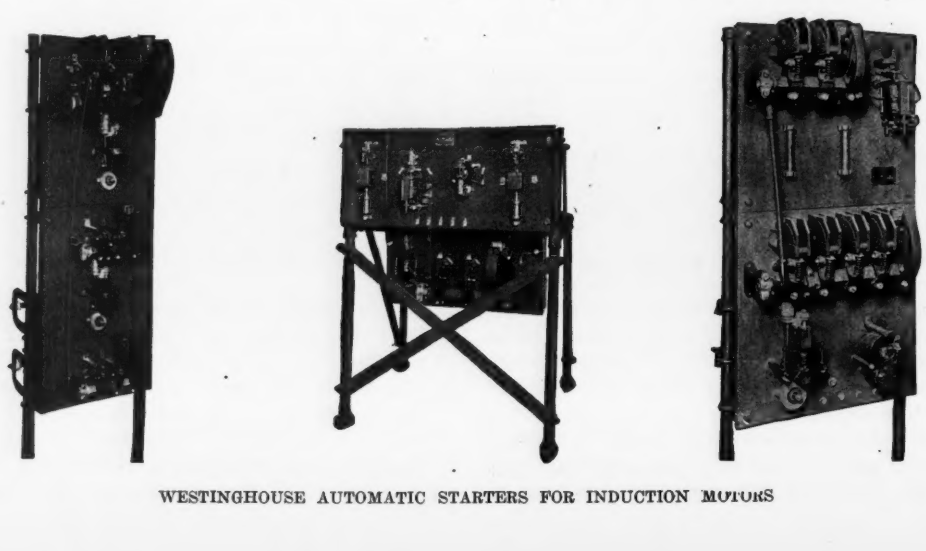
HYDRO-ELECTRIC POWER is to be developed in Tasmania from Lake Margaret by the Mount Lyell Co., an addition of 8000 hp. to the present capacity being involved at a cost of $344,200. A scheme is also being investigated for installing a 30,000-hp. plant on the King River.

Automatic Starters for Induction Motors

DUE to the unprecedented demand for manufactured products of every kind, industrial plants in all parts of the country are being taxed to their utmost capacity. In addition, the cost of labor and machinery has been increasing at an extremely rapid rate. The magnitude of these factors has forced manufacturers to employ every means available in an effort to increase production or to reduce operating expenses. This may be accomplished by reducing the number of operators, by simplifying the duties of the present operators so that more attention may be devoted to the production of a larger quantity and a higher grade of product, or by furnishing better protection to the apparatus installed, thereby insuring continuity of service.

One of the chief factors by which the desired results may be accomplished is the use of automatic starters and controllers for the motor-driven machinery employed. Foremost among the companies producing such control apparatus is the Westinghouse Electric & Manufacturing Co., several of whose starters are shown in the accompanying illustrations. These starters are for use with single-phase or polyphase squirrel-cage and wound-rotor induction motors, where it is desired to start the motor from a remote point or where automatic acceleration is required to guard against improper starting by unskilled operators. They are simple, reliable, and rugged in construction, consisting of a magnetic contactor panel and a master switch, which may be either a push button, a float switch, a pressure regulator, or similar device for closing the control circuit, depending upon the service. The vital element is the magnetic contactor. The contactors are opened by strong spring action assisted by gravity; the destructive action of the arc is reduced to a minimum by strong blowout coils and arcing horns.

The operation of the starters is very simple. When starting motors driving line shafting, woodworking and machine tools and similar apparatus, it is only necessary to press a button, close a small knife or snap switch. The starter then automatically makes the proper connections to limit the starting current to a suitable value and to vary the time required for acceleration according



WESTINGHOUSE AUTOMATIC STARTERS FOR INDUCTION MOTORS

to the load on the motor, thus preventing damage to the machinery by too slow or too rapid acceleration, and saving time by bringing the motor to full speed at the most rapid permissible rate. When used for pump or compressor service in connection with a float switch or pressure gage, the action of the starters is entirely automatic, the motors being started when the pressure or liquid level of the tank controlled falls to a predetermined point and stopped when the desired maximum pressure or level is reached, or vice versa.

The automatic starters for squirrel-cage motors are most frequently employed for starting motors operating centrifugal pumps, air compressors, fans, blowers, metal working and wood-working machines, and other apparatus requiring starting torque less than full-load torque. This type of starter, however, owing to the wide application of squirrel-cage motors for industrial service, can be applied economically for starting service in nearly every industry.

Squirrel-cage motors of 5 hp. and smaller are usually connected direct to the line. Large squirrel-cage motors are first impressed with low voltage from auto transformers or connected to the line through resistance so that in either case the starting current is reduced. When the speed of the motor has reached such a point that the starting current has decreased sufficiently, the motor is then automatically connected to the line.

The automatic starters for wound rotor motors are particularly adaptable for starting motors driving plunger pumps, positive pressure blowers, air compressors, long line shafts, and loads having heavy inertia. The severe starting conditions encountered in this class of service require from 100 to 200 per cent full load torque in starting, making automatic starting a very desirable feature.

When an automatic starter is used in connection with a wound-rotor motor, the line switch is first closed, with the maximum resistance in the rotor circuit. When the speed falls to a predetermined value, a relay closes a magnetic contactor which cuts out a part of the resistance in the rotor circuit. Each contactor operates in a similar manner, cutting out its portion of the resistance at the proper time until all the resistance is short-circuited by the last contactor.

The power on any circuit may fail suddenly and it is therefore important that some protection be afforded both operator and motor against an unforeseen return of power. This protection may be provided for motors operating pumps, compressors, etc., by a low-voltage release to disconnect the motor from the line when the voltage is low or power fails entirely. Then, as soon as power returns, the motor will automatically start up again. In many applications, however, such as for motors operating machine tools or wood-working machines, low voltage protection is required. Motors so protected are disconnected from the line when power fails and will not start when power comes on again until the operator presses a button or manipulates a similar device; hence, there is no danger from the unexpected starting of a machine.

The advantages resulting from the use of automatic starters for induction motors comprise, absolute protection to both operator and expensive machinery, proper starting at the most rapid permissible rate, economy in operation and maintenance, convenience of remote control, and automatic operation.

Sampling of Flue Gases

SOME COMMON ASSUMPTIONS THAT RESULT IN ERROR. BY L. A. A. KARL

IN the analyses of flue gases, it is necessary to use great care and good judgment in the sampling of the gases in order to get results which are actually representative of the conditions to be tested.

The nature of the firing must first be considered and particularly whether the firing is intermittent, as in hand firing or continuous, as in automatic stoker firing. A hand-fired furnace will necessarily show great variations in the composition of the gases of combustion and such variations will follow each other in rapid succession. On this account, it is necessary to take many samples at short time intervals, say every two minutes.

If the samples are taken on equal time intervals, the resulting averages will be nearer the truth than if an equal number of samples had been taken, but on unequal time intervals. A common fallacy committed by testing men is to throw out certain results because they are too far from what would be expected. Such cases depend on an open fire door or a fire too heavily covered with green coal or similar cause which is part of the performance and rightfully should have its share in determining the average results.

In stoker firing, the care as to frequence and equal time intervals becomes less important, particularly when the boiler output remains constant. A common mistake is the belief that a good average sample can be obtained by gradually drawing off a sample for a long period, say an hour or more, and we quite often see in our technical periodicals apparatus for this purpose described and recommended.

Taking such a sample is particularly a bad method for a hand-fired boiler, as the losses based on the analysis of the average sample is sure to be wrong, even though the composition of this sample may truly represent the average composition of the flue gases during the period.

The reason for this is that the losses are not in direct proportion to the percentages of the constituents of the gas, but enter into the calculations in such a manner as to make averaging mathematically incorrect. The following example will bring this point out clearly:

Suppose a coal was burnt that had the following characteristics:

Actual B.t.u. available in coal per pound as fired, 13,000 B.t.u.

The coal contains, say, 75 per cent carbon. For simplicity's sake, no attention will be paid to the effects of moisture, hydrogen, unburned hydrocarbons, and combustible in ash.

Assume that two samples had been taken which analyzed as follows:

Sample No. 1, 10.2 per cent CO_2, 2.2 per cent CO.
Sample No. 2, 5.6 per cent CO_2, 0 per cent CO.

Average, 7.9 per cent CO_2, 1.1 per cent CO.

Sample No. 1 would represent a sample taken when the fire was heavily covered by green coal, while sample No. 2 would have been taken when there was a thin fire and ample draft.

For calculating losses due to sensible heat in gases it will be assumed that the gases leave the boiler at 550 deg. F. and that the room temperature is 80 deg. F.

The losses due to the sensible heat in the gases are:

For sample No. 1—

$$L_{1a} = \frac{100 \times 0.6 \times 75 \times (550 - 80)}{13{,}000\ (10.2 + 2.2)} = 12.1 \text{ per cent.}$$

For sample No. 2—

$$L_{2a} = \frac{100 \times 0.6 \times 75 \times (550 - 80)}{13{,}000 \times 5.6} = 31.1 \text{ per cent.}$$

The average loss due to sensible heat then becomes $L_a = 21.6$ per cent.

If, instead, the calculation had been based on the average analysis, the average loss would appear to have been:

$$L^1_a = \frac{100 \times 0.6 \times 75 \times (550 - 80)}{13{,}000 \times (7.9 + 1.1)} = 19.3 \text{ per cent.}$$

instead of 21.6 per cent, which is correct.

An error of over 10 per cent is thus made.

Now, considering the losses due to incomplete combustion, it will be shown that this fact is still more marked and that the errors due to an average sample may be entirely misleading.

These losses are:

For sample No. 1—

$$L_{1b} = \frac{10{,}200 \times 75 \times 2.2}{13{,}000 \times (10.2 + 2.2)} = 10.4 \text{ per cent.}$$

$L_{2b} =$ 0 per cent.

$L_b =$ 5.2 per cent.

By using the average of the analyses, one would suppose the average loss to be $\frac{10{,}200 \times 75 \times 1.1}{13{,}000 \times (7.9 - 1.1)} = 7.2$ per cent, instead of the correct value, 5.2 per cent, an error of over 38 per cent.

The table below will give a summary of these results:

	% CO	% CO	L_1	L_2
Sample No. 1.....	10.2	2.2	12.1	10.4
Sample No. 2.....	5.6	0	31.1	0
Average sample....	7.9	1.1	19.3	7.2
True average	7.9	1.1	21.6	5.2

In taking gas samples, the object of the analysis will have an influence on where and how the sample should best be taken.

If it is the purpose, for instance, to check up the combustion in the furnace, the samples should be taken as close to the furnace as possible, but should not be drawn from the furnace itself. In case the sample were taken far from the furnace, it would be liable to mislead one to believe that the fuel bed was being supplied with too much air, when the fact might be that the excess air had entered the setting through leaks beyond the furnace which had nothing to do with the combustion proper. That the samples, on the other hand, should be taken well out of the actual zone of combustion is clear, as the products of combustion have not yet been completed there.

Should the purpose for which the samples are taken be to determine the flue losses in a boiler test, as another instance, the samples must be taken at the point where the gases leave the boiler, as it is in this case necessary to include all air leakage in the boiler setting. In this connection, it might be pointed out that whenever flue losses are concerned, the gas samples should be extracted at or near the point where the temperature reading is taken in order to apply the proper temperature to the corresponding gas volume.

The pipe used for drawing out the sample should also be shaped for its particular purpose. In case it is a matter of checking up combustion, the pipe should extend into the middle of the setting and there terminate open ended. This will exclude as far as possible air leakage from the setting above the fire.

If, on the other hand, it is a matter of determining flue losses, a perforated closed end pipe extending the whole width of the setting is to be recommended.

In taking gas samples, the utmost care should be used to exclude air leakage in the pipes and connections through which the samples are carried, as a very small leakage there will bring entirely wrong results, due to the small quantity of gas passing and the consequential great dilution due to the air leaks. If an Orsat apparatus is used for analyzing the samples, the same applies and leaky connections in an Orsat are common causes of bad tests.

That air leaks play an important part, we know, and I believe the following figures, which are not extreme exceptions from the ordinary case, illustrate this point well.

A B. & W. boiler and economizer were tested at different points, and the following readings were taken:

In the first pass of the boiler, 15.3 per cent CO_2.

In the uptake of the boiler, 13.5 per cent CO_2.

At the entrance of the economizer, 11.9_2 per cent.

At the suction side of the induced draft fan 9.1_2 per cent.

An economizer is often guilty of very bad air leaks and it may, in this connection, not be out of place to point out that the induced draft fan must be capable of not only handling the quantity of gas leaving the boiler, but this quantity plus a substantial amount of air leaked in on the way from the boiler to the fan.

In a general way, the gas analysis is the most important guide the engineer has to show him the road to economy; but the engineer must use this guide carefully and intelligently if it is to give him the full measure of benefit and the first step is to sample the gases properly.

REPORTS of the Railroads War Board indicate that shippers are giving wide co-operation in the campaign to use the capacity of existing freight cars to better advantage. It is estimated that during the month of July, savings in space were effected which would increase the number of cars available by practically 120,000. Co-operation comes from firms in all lines of business and in all parts of the country, the reports indicating that the loading per car has, in many instances, been doubled.

Preventing Trouble with Spark Plugs

By F. E. Bacon

IF, when purchasing spark plugs, we would pay more attention to the positions of the pins and their points, we would experience less trouble with their operation.

Some cylinders frequently receive too much oil, which gathers at the points of the pins when they are as shown in Fig. 1. Pins of this form and in this position have a tendency to carry the oil so as to collect at the gap, and thereby simply drown out the spark and prevent firing.

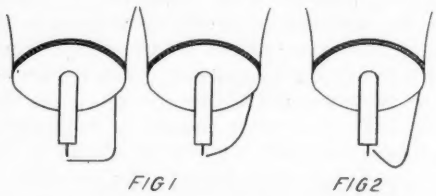


FIG. 1. OIL WILL READILY COLLECT WITHIN THESE SPARK GAPS AND PREVENT FIRING

FIG. 2. NO OIL CAN COLLECT WITHIN THIS SPARK GAP AND PREVENT FIRING

If we will notice the plugs and see that the pins are set with the points as in Fig. 2, collecting of the oil at the gap will be eliminated.

Consumers Urged to Reduce Coal Requirements

War Time Demand Causes National Chamber Committee to Make Country-wide Appeal

NOW is the time for every user of coal to endeavor to reduce his requirements according to the Committee of the Chamber of Commerce of the United States cooperating with the Council of National Defense which sends forth the following five suggestions in a special war bulletin.

1. Inquire into the methods employed by your fireman and consider his methods in relation to those suggested by the Bureau of Mines.

2. Learn what plants in your locality secure the best results from coal.

3. Endeavor to have the wasteful users of coal profit by the best experience of the locality.

4. Improve all local methods by consultation with the Bureau of Mines and study of the stoking methods recommended by the Bureau.

5. Buy your coal as near home as possible.

Today there is a limit to the amount of coal which should be mined, according to the bulletin. In the great concentration of national energy toward prosecuting the war, men are not available to open new coal mines to meet extravagant needs. Transportation facilities are burdened to the limit of capacity. These and other factors establish a definite limit to the amount of coal which should be made available for use during the war.

Another important phase of the situation comes from the control of coal prices by the government. An effect of such price regulation may be reduction in output. It is largely to be expected that the fixing of prices can be carried on without controversies with producers interrupting operations and without repressing the adventurous spirit necessary to increase output.

"Opposed to these limitations on the available supply of coal is the greatest demand for coal ever known," the bulletin continues. "The railroads are requiring more coal than ever before. The war and its stimulation upon industry has called upon our factories for an output beyond all previous peak loads. Our allies depend upon us for coal. Neutral countries depend upon us for coal. Good use can be made of all available coal.

"Under these circumstances, all business men are called upon to give thought to avoiding the waste of coal. Let every man consider how his coal requirements can be reduced. Let all organizations of business men engage in a vigorous effort to promote the discussion of wasteful methods in coal consumption and the adoption in all power plants of those stoking methods which produce power without waste of coal."

The Bureau of Mines has made a study for years of stoking methods. Elaborate investigations and experiments have been conducted and the results of what has been done are available to every user of coal. The Director of the Bureau of Mines desires that users of coal call upon this Division of the Government for advice and assistance.

In this connection, it may be said that the Bureau of Mines has analyzed samples of coal from all sections of the United States and is already prepared to give information regarding the best uses to be made of different kinds and grades of coal. Detailed experiments and investigations enable the Bureau to give effective assistance in bringing about improved stoking methods. Their tests and the experiences of users of coal demonstrate that an amazing saving may be had without change of coal or equipment by merely controlling the fireman and his method of putting coal under the boiler.

"There is great opportunity for associations and particularly engineering societies to conduct a campaign of education," the bulletin concludes. "Today a university in Tennessee, cooperating with the Bureau of Mines, is having men visit power plants in Tennessee to bring about the savings in coal consumption which come from consideration of the firemen's methods. Similar efforts should be made elsewhere."

Electrical engineers are needed for the Army Signal Corps because of the great use of electricity and apparatus in signaling. This branch of the service offers great opportunity for advancement to those who are familiar with electrical apparatus and machinery as signal officers and men are always in close touch with the General Staff. The Signal Corps needs men to bring it up to war strength. Write or apply to Signal Dept., 1320 Consumers Bldg., Chicago, Ill.

The original inventor of the spark plug was Lenoir. The type of plug which he designed for use in connection with his ignition scheme in 1860 had all the features of the modern plug.—Mechanical World.

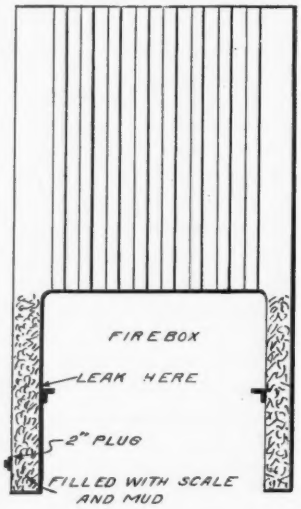
LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Cleaning Boilers

WHILE CLEANING boilers on a Sunday an engineer friend visited my plant. While I was coming out of the boiler through the top manhole, I was asked by my visitor if I opened the top manhole at each cleaning of the boiler on a return tubular boiler. He asked this question as if he thought this was not necessary. This question made me wonder whether there are many more engineers, firemen, etc., who do not think it necessary to open the top manhole at each cleaning and go into the boiler to wash down the scale and mud which is lodging above and between the tubes, upper shell and braces.

It seems to be the practice in some steam plants where return tubular boilers are in use merely to open the front manhole or handhole and wash the lower tubes and



CROSS SECTION OF VERTICAL BOILER, SHOWING LOCATION OF LEAK AND SCALE

shell only. Probably these men are under the impression that as the lower shell and tubes are immediately next to the fire, where the heat is most intense, only this part of the boiler must be kept clean to prevent the danger of overheating the metal. But where does the efficiency of the boiler come in? If the top rows of tubes, heads and shell are not kept clean of scale and mud, it is impossible to wash the upper tubes, shell and part of tube heads thoroughly where only the lower manhole or handhole is knocked in.

Another engineer of a small steam plant told me that he washes boilers on a Saturday afternoon where the plant is in operation till noon. I would like to know how it is possible to wash a boiler thoroughly a few hours after it was in operation, due to the heat of the brickwork, etc. I am quite sure that where this practice exists the top manhole is not taken out. I suppose all that is done is to cool off the boiler as much as possible by running cold water into it (which is injurious to the boiler, due to unequal contraction), then the lower handhole or manhole plate is knocked in and holds the hose in awhile until clean water appears at the blowoff pipe opening, then the boiler is closed and filled with water, when all is ready to start fire Monday morning. I suppose men of this type who are in charge of one or 2-boiler plant where the boilers must be cleaned on Sundays, prefer to ruin a boiler in this way, rather than to clean them on Sunday, when the boiler and brickwork, etc., would cool off considerably from Saturday noon or night until Sunday morning.

Where there are one or two boilers in a plant and these must be cleaned when the plant is idle, such as Sundays or holidays, I carry out the following program: The night before cleaning day, steam pressure is run down as much as possible before shutting down, also the fires are kept low. After shutting down, the stack damper is left partly open all night, which cools off the brickwork and lowers the steam pressure. Should there be any steam left in the boiler next morning, this is blown out, then the top manhole plate is knocked in, blowoff valve opened, and the hose placed in manhole, held there until the boiler is cooled off so it can be entered. Then the top rows of tubes, shell and heads are thoroughly washed with a good water pressure. After this part of the boiler is clean the hose is placed in the lower hand or manhole and mud and loose scale washed out as much as possible through the blowoff. Should there be a front manhole, this is entered and all remaining loose scale scraped toward the front, but should there be a handhole, a scraper with a handle 2 or 3 ft. longer than the boiler is used to pull the loose scale to the front, while a candle or electric lamp with an extension cord, is used at the end of a long wood stick which is moved forward and back so as to light up the interior of the boiler so the loose scale can be seen, and also see the condition of the boiler after all loose scale is out. The boiler receives another washing to remove all remaining mud and fine scale. Then needed repairs are made, such as pipes and valves, etc. After this boiler is closed and filled with water, should there be no night watchman at the plant, a slow fire is made and steam raised and fire banked till Monday morning. Of course, where there is a watchman, he can start fire early Monday morning.

A short time ago, the writer had to examine a small vertical boiler, used in a steam traveling crane, which leaked badly in the fire box. I found that the boiler leaked in the back of the fire box at the inside shell, which was burned badly in places. After knocking in

some of the handholes, I found that the space between the two shells in the fire box at back of boiler was nearly filled with scale to the lower tube head, as shown in the illustration. As the engine is fastened to this part of the boiler and no handhole near, it is quite hard to get at this place to remove the scale and mud. I suppose most men who had charge of the boiler did not bother much to keep this part clean, so it was left alone until there was trouble.

We got busy with a hose and water pressure and some bent scrapers through the nearest handhole to the scale. There was a 2-in. brass plug at the bottom of the boiler near one side of the engine, which looked as if it had not been removed since the boiler was in use. A 24-in. pipe wrench was used to loosen the plug. By holding the hose in the handhole and using a scraper at the plug opening, all scale and mud was removed and boiler sent to the repair shop to place a patch over the damaged part. H. A. JAHNKE.

Oil Pump; Convenient Packing Hook

FIGURE 1 illustrates a device I made to pump oil out of barrels where one has air compressors in the plant. Use 1-in. pipe and turn down a pipe coupling to a taper fit and thread it as shown in the sketch. Use a 1½-in. auger for tapping the barrels. At A is shown how I fasten the air tube, which is ⅛-in. brass tube. I have

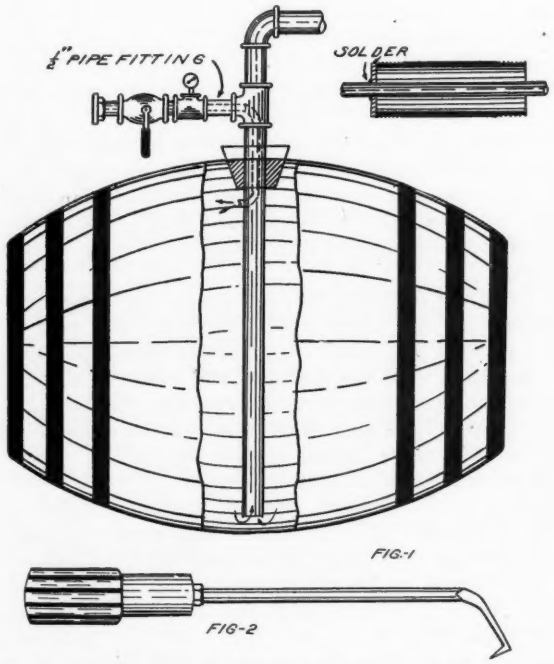


FIG. 1. METHOD OF ATTACHING COMPRESSED AIR PIPING TO OIL BARREL

FIG. 2. PACKING HOOK

used this and it works satisfactorily. Care should be taken not to put too much pressure on the barrel, about 4 or 5 lb. is sufficient.

Figure 2 is a convenient packing hook that I have made which is more durable than the ordinary kind.

A. L. JOHNSON.

Running Semi-Condensing During Heating Season

THE ILLUSTRATIONS show how a simple condensing engine was changed in order to use half of its exhaust steam for heating feed water and the house.

The cylinder was moved on the foundation to allow access beneath, when by means of an electric drill, hammer and chisel two openings were cut, and a special casting with a connection for an exhaust pipe bolted on.

Four bolts were put across the exhaust chest over the usual exhaust opening with a piece of sheet iron on either side, a snug fit lengthwise. Then a blank flange was bolted over the central exhaust, an inch hole was bored in the chest inside the two iron plates referred to,

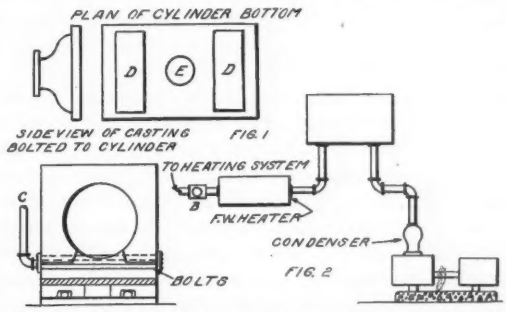


FIG. 1. SPECIAL CASTING AND PLAN OF CYLINDER BOTTOM

FIG. 2. ARRANGEMENT FOR POURING BABBIT AND SCHEME OF EXHAUST PIPING

and 1-in. pipe screwed into it to form a pouring gate as shown in Fig. 2.

A cheap grade of babbit was run in the pipe C and then flowed into the desired bridges and allowed to cool. It was then calked as well as possible, through the openings DD and E, Fig. 1.

An exhaust pipe was bolted to the crank end and carried to the feed-water heater, then on to the heating system, being provided with valves to enable the exhaust to be turned into the condenser during the non-heating season. The head end was arranged to run condensing at all times as shown. RECEIVER.

Mandrels Are Not Always Necessary*

I HAVE often ridiculed the idea of using a special mandrel for babbiting bearings, and in most instances I am still against such practice, because in my experience I have never had a failure by using the shaft itself as a mandrel and pouring the babbit directly around the shaft. In general, the way to do it properly is to do it quickly. Take all the time you want for preparing the molds, and prepare them in such a way that the babbit can be poured almost instantly. By pouring quickly all sides of the shaft are heated simultaneously, expansion is the same all over, and there is no spring in one direction. The danger that must be overcome is the danger of warping, which will occur when the babbit is poured slowly and on one spot on the shaft. That spot becomes highly heated, expands, and springs the shaft in such a way that the hot spot will be on the convex side. Before the shaft can spring back, the babbit solidifies and holds the shaft in a bent condition. Sometimes

*Copyright, 1916, by W. F. Schaphorst.

this bend is very slight, so slight that the shaft can be turned any way, due to the clearance allowed; but the bend can be actually "felt" with the hand, because in one position it turns more easily than in any other.

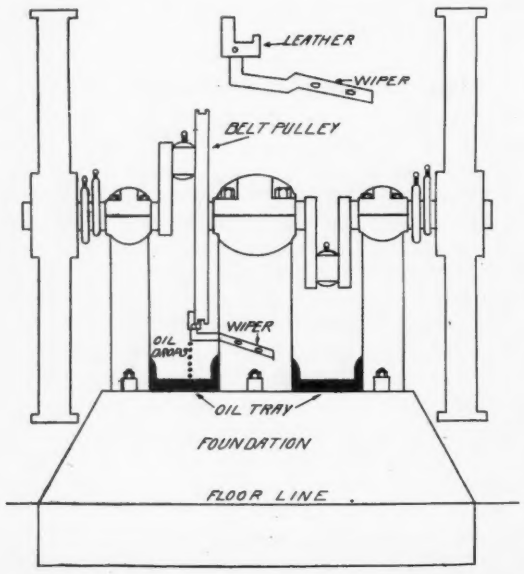
To prepare the shaft for the mold it is a good plan to burn some oily waste and create an oily soot on the shaft. This soot serves a double purpose. It provides the necessary clearance medium, and it is a good insulator against heat. If you have ever had anything to do with boilers, you know how effective soot is as an insulator. If you fear that the soot isn't thick enough, wrap a thickness or more of thin paper around the soot. Then you will have a double insulator. A string tied around the paper further forms oil grooves that are generally of value in a bearing.

Another difficulty that attends the use of a separate mandrel is that the shaft wears with use, whereas the mandrel doesn't wear. That is, if we have a 2-in. shaft to begin with, and a 2-in. mandrel sawed off the same shaft, we can do a very good babbiting job the "first time," because we are absolutely certain that the mandrel is the same size as the shaft. We then grease and lay the mandrel away for future use. But the shaft runs for a year and wears slightly. Then, in bringing the mandrel back into use for rebabbiting the bearing, the finished job may come out too loose. To avoid this difficulty, first-class millwrights make special wooden mandrels for every important job, modeling the wooden mandrel to the exact size of the metal shaft. It is well enough for manufacturers to use mandrels; I would use them myself if I were a manufacturer; but the millwright should use his own judgment as to whether or not a mandrel is necessary on special jobs or if it would pay to make one.

W. F. Schaphorst.

Keeping Oil Off Governor Pulley

Some time ago, a horizontal cross-compound Meyer cutoff high-duty pumping engine in my charge caused considerable annoyance. Much of the oil fed to the high-pressure crank brasses worked over onto the governor pulley where it was taken up by the belt and scattered quite liberally over the steam end of the pump. To overcome this, I took a piece of strap iron 1¼ in. wide and 3/32 in. thick and together with a small piece of leather made a wiper of the form shown. The leather was riveted to the strap iron and the latter, which was slotted to allow adjusting was bolted to the engine base.



OIL WIPER AND METHOD OF ATTACHING IT TO ENGINE FRAME

With this in place so as to cause the governor belt pulley to ride against the leather wiper, all oil is removed as quickly as it accumulates on the rim of the pulley and drops into the oil tray below. After 3 yr. of continuous use the original leather on this wiper is still quite serviceable.

Arthur Schau.

The Ammonia Condenser

There is probably no more useful and certainly no more abused and neglected part of a refrigerating plant than its condensers. A few years ago, almost anything that would condense ammonia would answer the purpose, as live steam had to be used for distilling in addition to the condensate, so a little power more or less made no difference.

With the advent of the raw water ice plant with its central station power, there came several improvements in the ammonia condensing apparatus, resulting in a great saving of power. An ice making or refrigerating plant is no more efficient than its condensers, as every pound of ammonia evaporated must be condensed again; in other words, every unit of heat absorbed in the evaporation of ammonia must be given off to the condensing water in addition to the heat of compression, so it can be readily seen that the quicker this is accomplished the more efficient is the whole plant. Another object is to get the condensed ammonia as near to the temperature of the condensing water as possible. This object resulted in the counter current and double pipe type of condensers.

From my own experience, I prefer the double pipe condenser if the water is not too dirty; but with any kind of deep well water they require regular cleaning, as the water contains sediment and minerals that will deposit in the pipes, cutting down the efficiency in a short time. It is surprising what results a flue brush and a little elbow grease applied at regular intervals will accomplish in the way of keeping the head pressure down to where it belongs. Several prominent authorities claim that every 10 lb. increase in head pressure resulted in decreasing the capacity of the machine 3 per cent with a like increase in power consumed; but I have known cases where it made a great deal more difference than that, especially if one is a little short on condensing water to start with. So one can readily see the advantage of keeping the pipes as clean as possible, especially if the management keeps close tab on the power bills.

I visited a large ice-making plant some time ago and noticing that they carried nearly 200 lb. head pressure, remarked to the engineer that his condensing water must be rather warm. He said that he had 50 deg. F. water and lots of it, but couldn't keep the head pressure down. Removing one of the return bends, we found the pipes so full of slime that it was nearly impossible for any water to get through. After cleaning his condensers

thoroughly, his head pressure dropped to 135 lb. This was a plant of over 100 tons ice making capacity, electric driven, and they were paying 1 cent per kilowatt-hour for power, so you can imagine the difference made in the power bills besides the resulting large increase in capacity.

The average ice machine builders generally place the condensers in one corner, so that you have to tear down the side of the building to get at them. Then they tell you to keep the expansion coils clear of frost and to maintain the brine coolers clean, also about purging for oil and air, but not a word about cleaning the condensers occasionally. Then eventually the head pressure begins to climb and the capacity of the machine begins to drop and the engineer being new on the job, begins to look everywhere except the right place for the trouble. A dirty condenser will no more do good work than a dirty boiler, and an ammonia compressor cannot handle 1 cu. ft. of gas more than the condensers will take care of.

Get the best type of condenser you can, and keep it as clean as possible. R. L. M.

Flotsam and Jetsam

CONDENSER intake screens are known to pick up some queer objects in performing their daily duties, but an account of the strange and unexpected items which find their way into a factory with the raw material would often be almost unbelievable.

I have in mind some happenings gathered from sugar factory experience, and my earliest recollections of the kind have reference to the occasion when, as a 10-yr.-old kid, I watched through the factory window while my big brother nearly had heart failure trying to stop his engines in time to save the life of a straw dummy caught in the crushing rolls.

He had fired me out of the mill by the neck the previous day, and revenge was sweet. The dummy was of my making and was placed by me in the feed carrier the night before while the watchman was asleep, and when my brother discovered whose Sunday "pants" constituted its posterior extremity, the climax was reached and my cup of bliss overflowed. They were his!

But retribution has followed me down the years, and these few remaining gray hairs owe their color to a sequence of horseshoes, trace chains, coupling pins, fishplates, cultivator parts, brickbats, tin cans and scrap iron which, if piled in a mass, would reach higher than the smokestack. Each item represents an act of pure carelessness, malice, or ignorance on the part of some field hand who thereby contributed his mite toward the depreciation of the crushing plant and the customary grouch of its engineer.

Carpenters employed in repairing the flumes which transport the cane to the mill, have a habit of losing hammers, axes and even sledges, in the flumes while at work, and of coming down to the mill to ask if we had seen their tools. This only happens once with a given man, for after such confession of guilt, it becomes my privilege and pleasure to rend him asunder and scatter his fragments abroad over the landscape.

Other things than hardware are quite common. At the time of a freshet in the hills, it is not unusual for the crusher feed attendant to take a string of fresh fish home to the "Missus." These come in with the cane and are quite welcome, as also are occasional fowls and ducks that fall in the water and come down partly suffocated.

In one instance that I know of, a paper parcel was rescued and found to contain four sticks of 60 per cent dynamite, primed with fulminating caps. The scoundrel who thus tried to wreck the mill was caught and is now, by special request, devoting 5 yr. to a course of study in geology.

The strangest case on record is that of a 2-yr.-old baby who fell into the flume about 2 mi. above the mill, spent over an hour under a mass of cane in the storage line and was rescued at the crusher, alive and unhurt.

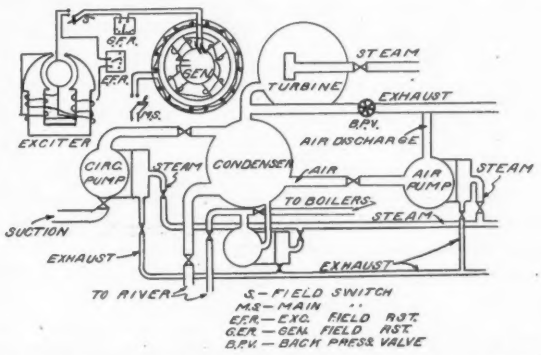
H. K. SCHOLEFIELD.

Sketching as an Asset

A MATTER of considerable importance in the business of engineering is one's ability to draw a plain sketch of a mechanical arrangement or device. Nearly all engineers have this ability; but the point is that if the best results are desired, one's ability must be cultivated along these lines.

In a marine service examination, the following question was on the board: Consider a condensing turbine, driving an a.c. generator—give a list of the necessary apparatus to put these units in service, and tell how they would be connected together.

I was the only candidate to submit a sketch as my answer, and after the examination the examiner commented on the simplicity of my sketch as compared to some of the long answers given.



SKETCH SHOWING NECESSARY APPARATUS AND CONNECTIONS WHERE A TURBINE IS RUN CONDENSING DRIVING AN A. C. GENERATOR

Another point of value in work of this kind is that it makes studies interesting. Ask yourself the following questions, then sketch out the lines from memory, after which look over the actual installation and find out what details you have left out. I have no doubt you will be surprised how little you know about some of your pipe and wire lines, the location of valves, etc.

Show the wiring connecting an exciter with a generator.

Sketch out the piping details between a cross-compound engine and the boilers.

Show the piping and valves necessary, where an accumulator, four presses, and a hydraulic pump are tied together. A. D. PALMER.

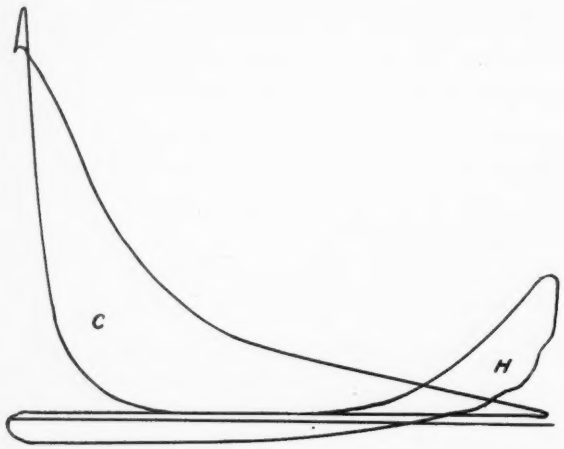
Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

What Do You Think?

THE ACCOMPANYING indicator diagram was taken from a Ridgway four-valve nonreleasing Corliss valve engine when running with no load. This card shows all the work being done on the crank end, and that the head end was cutting off so early that the steam expanded below the atmospheric line, forming a negative loop. The steam pressure was 100 lb., speed 200 r.p.m., cylinder 19-in. and 18-in. stroke; scale of spring was 40 lb.

The card was taken some time ago in checking up the valve setting after overhauling the engine, and is a friction load card only.



INDICATOR CARD SHOWING CRANK END TAKING GREATER SHARE OF LOAD

It is not a freak card nor one taken with the head end cock partly closed, as others taken immediately after were the same. It simply indicates that the valves were not properly set, the misadjustment being caused by the rods all being removed, and not properly replaced.

The fault was corrected in a short time; but it would be interesting to know what some of the indicator experts think of this card, and just what they would do to correct its faults. J. H. CASE.

How May He Eliminate the Rattle?

WE HAVE a 16 by 42-in. Cooper Corliss engine in which the valves rattle. The engine is carrying a light load and therefore cuts off early in the stroke. I have tried feeding more cylinder oil, but to no avail. The cylinder and valve chambers were rebored about 4 yr. ago and new valves fitted. Cylinder, chambers and valves seem in good condition and well lubricated.

I took charge of the plant about a year after the reboring took place and noticed a rattle even then, but the rattle becomes more pronounced all the time. I have consulted other engineers and they all seem agreed that the rattle is due to the light load carried. The steam pressure carried is about 80 lb., but this sometimes goes up to 100 lb. As the pressure rises, the rattle becomes more pronounced, seeming to indicate that the light load theory is correct.

The engine is in line and everything works fine. The rattle is rather annoying and I would like to eliminate it if possible. I get fine indicator cards regardless of pressure and load.

I would like to hear from somebody who has had similar trouble and found a remedy for it. G. R.

Is the Indicator at Fault?

REFERRING to the three cards shown on page 667 of the Aug. 15 issue, E. C. D. states that No. 1 was taken with an old and reliable indicator, No. 2 with a new indicator; but he fails to say which indicator was used to take card 3, though he seems to imply that it was the same indicator used in taking No. 2.

Cards 1 and 2 are nearly enough alike to permit comparison. If all other conditions were identical, excepting the indicator, then there can be but one answer, namely, the hump is in the indicator and not in the engine. Inertia of moving parts of the indicator pencil arm and piston will frequently cause a wavy line, especially when there is proper lead but low compression. In card 3 (if made with the new indicator) the wave is lacking, probably because the card shows an absence of lead and the pencil moves up slowly with no vibration at the top.

According to E. C. D., card number 3 was "taken from the same engine, same valve setting, etc.," but there is evidence of a change of lead between the two cards. Later in the article, he states card 3 was taken with a third indicator which showed the same waves on light load as the second indicator showed. He does not say, however, whether it was with the valve setting of numbers 2 or 3. I do not believe that changing the load would affect the waves unless the valves close slowly after the hooks are released. The usual tendency of slow-closing valves is merely to round off the point of cutoff. My guess is that an indicator that will give a card like 3 on heavy load will give a card like 1 on light load.

If E. C. D. will give his engine all the compression possible without spoiling the rest of the card, I think he will be able to have a quiet running engine with proper lead.

He speaks of compression causing the waves in the admission line of the card. Generous compression would help to eliminate the waves if caused by inertia. Exces-

sive compression will cause the steam valves to slam when lifted from their seats, but any compression whose terminal pressure is less than steam chest pressure will help the ordinary engine to run quietly as well as cutting down the water-rate of the engine.

On page 441 of the May 15 issue, Charles J. Mason says: "The less the compression, the greater the load the engine will carry, with a given quantity of steam."

I think he meant with a given cutoff, not "quantity of steam." The clearance space must be considered. If there is high compression, little steam will enter the cylinder at dead center, even with generous lead. With little or no compression, the entire clearance space must be filled with live steam at steam chest pressure before any work is done on the piston. The result of low compression is usually a higher steam consumption per indicated horsepower-hour, but greater power for a given cutoff.

High or moderate speed engines with low compression will require more frequent keying up than the same engines with high compression and the steam rate will be higher with the low compression.

J. C. Hawkins suggested the possibility of a dirty or sticking indicator causing distortion of the cards. There is no indication of such trouble in any of the cards under discussion. It is the easiest of all troubles to recognize, though not always so easy to eliminate. A sticking piston will give a step-like line for expansion and compression curves; that is, there are no curves, but a series of vertical and horizontal lines that look like a picture of a pair of stairs. C. E. MOULSON.

E. C. D. HAS NO "hump" in the steam line of his cards, for the reason that at no time does the steam or expansion line show a greater pressure than at any preceding point.

There is, however, a drop in the steam line of card 2 (in issue of April 15). This drop is often due or met with in engines having a large steam chest and a small steam pipe. In such engines, the large chest acts like a reservoir and allows the steam in the cylinder at the beginning of the stroke to become almost equal that of the boiler pressure; but if the steam pipe is too small, this pressure cannot be kept up when the piston starts to move on its stroke, and there is where the drop in the steam line comes in.

He says that card 3 is taken from the same engine, same valve setting, etc.; also, that when taken with another standard instrument, it shows the same on light load as the other instrument. But he did not say that the steam pressure had been raised or more load added.

Card 3 shows, however, that the boiler pressure was raised enough to allow ample supply of steam during the time the steam line was being drawn on the cards or the time the steam valve remained open.

I would advise E. C. D. to advance his eccentric a trifle and see that he had proper compression by adjusting his exhaust valve rods. Giving more compression will stop the pounding when he advances his eccentric.

F. E. BACON.

CARDS 1, 2 AND 3 are fairly good. The trouble, I should, however, say seems to be a faulty indicator string, by which I mean a string that stretches unnecessarily. J. M. LEITCH.

COMMENTING ON the indicator cards on page 667 of the Aug. 15 issue, if there is any defect in the valve setting it is more apt to show up on heavy load, as in card 3. While card 1 is nice looking, it indicates insufficient compression. It is my opinion that the humps on card 2 were caused by having too much slack in the indicator cord.

Card 3 shows admission too late; steam valves do not open until after the engine passes center; release is too late; more is required; the cards show high steam pressure and heavy load.

I would suggest that he give the engine 1/64 in. lead and added compression until the compression curve shows up similar to the exhaust curve in card 3.

A. R.

Eliminating Corrosion

I NOTE in the July 1 issue that W. S. is having trouble with corrosion and pitting in his boilers, and asks for information as to the cause and remedy.

W. S. does not state whether the corrosion and pitting are internal or external, either may be found under certain conditions. About 5 yr. ago, three of the boilers in our plant showed considerable internal pitting along the water line, and corrosion of the shell above the water line. These boilers furnished steam to a direct steam low-pressure heating system through a reducing valve, and also to a number of engines which exhaust into a hot water heater through an oil separator. The returns from the direct steam system were fed directly into the feed-water heater, and the returns from the exhaust steam heaters pass through a separating tank which floats off considerable of the oil, then returns to the feed-water heater and to the boilers. At the time the trouble occurred, a doubtful grade of cylinder oil was being used and some of it got into the boilers.

In order to prevent further action on the boiler metal, a more efficient oil separator was installed in the exhaust steam line, a small amount of soda ash was used in the feed-water heater, and the pitted spots were painted with a zinc paint, the idea of this being that if the pitting was caused by galvanic action the zinc would take the place of the steel as the active material.

We then received a different and somewhat better grade of cylinder oil. No further signs of pitting have occurred, although all of the direct steam returns and about 80 per cent of the exhaust steam returns are fed back into the boiler during the heating season.

In summer, the boilers use raw water almost entirely. The use of a small amount of soda ash—about 2½ lb., per 100 hp. per week 24 hr. service—has been continued, but for the last 2 yr. no zinc paint has been used. I am not positive as to the cause of the pitting and corrosion, as several remedies were taken at the same time, but am of the opinion that it was principally due to poor cylinder oil and inefficient separators. This allowed the oil to get into the boilers with the feed water, and its acids attacked the metal. Distilled water, such as the returns from heating systems which have not been exposed to air, also has a tendency to pitting and corrosion, and may cause serious trouble. I have in mind a large greenhouse heating system using return taps

to return the condensation from the houses to the boilers, in which this trouble was very serious. In this case, rain water was used in the boilers and there was no scale to protect the metal.

In my opinion, the secret, if it may be called a secret, of the lack of scale and corrosion troubles in our boilers is that the boilers are subjected to frequent inspection, by the engineer, and that they are thoroughly cleaned internally and externally, but especially internally by a man who is experienced in this work. He has full charge of the cleaning, which requires only a part of his time, the balance being spent in certain other work about the plant. We aim to use just enough soda ash to cut any oil that may get into the boilers, blow them down twice a day from the bottom and once from the top or surface blow. No other compound is needed. The water used is taken from the city mains, and is considered good.

J. C. HAWKINS.

W. S.'s TROUBLE from corrosion of boiler plates and tubes may be due to galvanic action, and as a remedy he might try using zinc plates secured to the tubes or stays. Plates 12 by 6 by ½ in. are about the proper size. The advantage of zinc plates lies in the fact that with galvanic or electrolytic action taking place in a boiler the current passes from the electro-positive element to the electro-negative element, wasting away or rather carrying away the positive element. As iron is electro-positive to brass and copper, any electrolytic action in the boiler between the iron plates and brass fittings will result in the corrosion of the iron plates or tubes; but by placing zinc or aluminum plates in the boiler the action will change, the zinc or aluminum being attacked and corroded instead of the iron, as both zinc and aluminum are electro-positive to either iron or brass. If the feed water, or rather make-up water, is of an acidiferous nature, corrosion will result, and the remedy usually applied is to neutralize the water, rendering it slightly alkaline by the use of soda ash or caustic soda.

An old remedy still in use is that of applying a thick coat of red lead mixed with boiled linseed oil (not raw linseed oil). The plates should be clean and dry and sufficient time should be given before refilling to permit the paint to dry thoroughly. Along the same lines, but giving better results, are internal boiler paints now on the market. They are composed mostly of carbon, or rather graphite, and, to the writer's knowledge, have given excellent results in several cases, especially when used in conjunction with some neutralizing medium. In one case, excessive corrosion and pitting were completely overcome by applying two coats of internal boiler paint and a feed water treatment of standard navy boiler compound holding the alkalinity at 3 per cent, scale formation was also greatly reduced. The water, in this case was slightly acidiferous.

A. C. MCHUGH.

What Causes the Pound?

IN REPLY to G. R. C., who shows cards on page 669 of the Aug. 15 issue, all cards indicate excessive lead. This should be reduced so that the admission lines will be perpendicular to the atmospheric line or, better yet, given a slight inclination inward, the probability is that the engine will run quieter. Again, the engine may not be in line or level, which will tend to make it run noisy.

The high-pressure card shows that something interferes with a free exhaust from this cylinder, because the back-pressure line begins to rise at once after the exhaust opens. An investigation should show why this is so.

If the receiver pressure can be changed, it may be suggested that G. R. C. change it when running or when stopped and note results. Due to wear of the bearings and other moving parts, another distribution of load in the cylinders may lead to quieter running.

RECEIVER.

FROM A STUDY of the cards of G. R. C., on page 669 of the Aug. 15 issue, I find from measurements that the crank end of the high-pressure cylinder is apparently doing more work than the head end. I also would advise giving both ends more compression, as I believe the pound he speaks of must be due to lack of sufficient compression and perhaps the fact that the engine is not properly keyed up.

While the low-pressure card is in general fairly good, I would suggest giving the crank end a trifle more lead and changing his valve setting to bring the admission line square at the corner of the steam line.

FRANK WELLS.

COMMENTING on G. R. C.'s indicator card in the Aug. 15 issue, I consider that admission occurs too early. The effect of this is to act as a resistance against the piston before it reaches the end of its stroke, which has to be overcome by the momentum of the flywheel, thus a pound at the crosshead and crank.

G. R. C. does not state the size of his engine, but I presume it is a long stroke tandem compound unit. Now, my experience has been for 24 in. and less stroke, 100 r.p.m. and over 1/32 in. lead; over 24 in. stroke, slower speed than 100 r.p.m. and 1/64 in. lead, and enough compression to cushion it over center. A. R.

IF G. R. C., WHOSE indicator diagrams were published in the Aug. 15 issue, would cut down his compression, I think his engine would run quieter. The compression in the high-pressure cylinder runs up to boiler pressure, and in the low-pressure cylinder nearly to the receiver pressure. Too much compression is as bad as too little, and probably more wasteful as regards fuel.

TOM JONES.

Getting a Raise

REPLYING TO "The Chief" in July 1, 1917, issue, page 559, I wish to state that I received a salary increase of $120 a year within 3 mo. I went about it as follows: The fireman I had on days was working for the concern 7 yr. I had been working here one year and 3 mo., so you can see what I was up against. The fireman thought he knew more than I did. Every time I made any change or worked about making improvements, the fireman went to our employer and told him what I did and that it would not work. I could not lay off the fireman on account of his being a distant relative. When the coal price came up, our employer asked me if I could save on the coal pile. I told him that I could provided he allowed me to change firemen.

He looked at me and said: "That man worked here 7 yr.; he ought to know how to fire."

I told him that he did not know anything about the man's work, and that relationship does not go in business. I furthermore stated that he would have to give me $5 a month more in pay and get rid of the man, or I would go. We got rid of the fireman and things are running along nicely, and I certainly got my raise of pay.

About two weeks ago, my employer bought some new machines for the machine shop and asked me to buy the motors for these machines. I knew that the line would be overtaxed with these new machines, so I stated to him that he was always adding new machines but he never thought to add a little over at the power plant. He said that he would take care of that end. So when I received my pay check, I noticed an increase of $5 a month. He must have misunderstood me or something; I was speaking for improvements in the engine room, but instead I got a raise in pay.

As to the indicator cards, I want to state that they are good.

WM. C. FUNK.

JUST A FEW WORDS, on my personal experience, to "Chief," who asks how others obtain salary raises. Eighteen years ago I started power plant work with a shovel, at 11 c. an hour. Today I am drawing $200 a month as chief engineer of an 800-hp. manufacturing plant. I have had 16 "jobs" in the 18 yr. in size from 40 to 3000-hp. I have worked in new up-to-date plants, and in some that were built before I was born (I am 45 now), and I have worked for some of the meanest as well as some of the best "bosses" a man could find. I have always followed one principle, and that has been to give my employer the best I had. Some employers have so little consideration for their employes that it is hard work to stick to this principle; but, when I reach the point where I can't stick to it, I quit and go somewhere else, hoping to find more appreciation. Sometimes I do and sometimes I don't.

In making up a list of salary raises I have had, I find I made seven raises by changing positions; I got three raises by fighting for them, threatening to quit if I didn't get them, and the last two have been voluntary ones from my present employer, for whom I have worked 7 yr. My experience, summed up, has convinced me that by sticking to the principle of doing my best, I have been able to increase my value, and if the position in which I happen to be does not seem to me to warrant more money, or my employer is unwilling to admit it, I look around and try to find one that pays better. My experience has fully convinced me that the faithful, conscientious employe, using the methods I have, will eventually reach the goal of voluntary salary raises. Try it, "Chief."

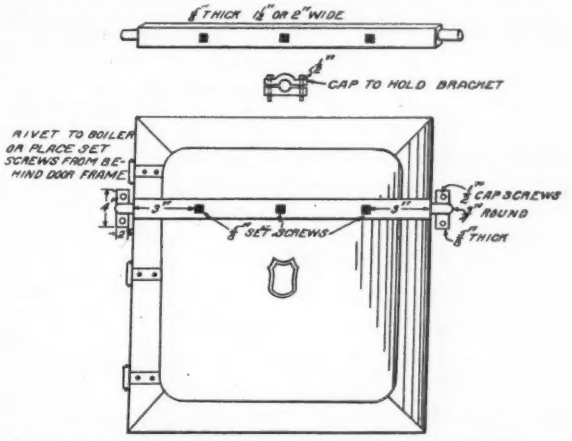
A. A. W.

Making Uptake Doors Tight

IN COMPLIANCE with the request of Receiver, appearing on page 324 of the April 1 issue, I wish to present a description of the method I employed to overcome trouble of a like nature.

The first thing to do is to clean the inside of the uptake doors thoroughly and then drill 4 holes for the insertion of ¼-in. stove bolts, about 1½ in. from each corner of the doors. Then obtain sufficient chicken netting to fit the inside of the doors, holding this in place by means of suitable washers under the nuts on the stove bolts; and while the doors are warm fill the inside of them with asbestos cement to a thickness of from ¾ to 1 in. with the chicken netting acting as a reinforcement to hold it in place. The lining thus formed will not only protect the doors, but will also tend to retain the heat.

After the doors are again in place, obtain a cross piece of the form and size shown in the accompanying illustration and by means of brackets riveted or screwed to the boiler fronts, place this cross piece over the door in the manner indicated. Then by means of the three set screws with which the cross piece has been provided, the door may be forced into place and proper shape.



DETAILS OF CROSS PIECE AND ITS APPLICATION

If the door be of large size, two of these cross pieces may have to be provided; and if any of the asbestos cement cracks during the straightening process, the openings thus formed may readily be refilled.

WM. DAVENPORT.

IN REFERENCE to C. H. W.'s letter appearing on page 666 of the Aug. 15 issue: I have two old Samuel Smith boilers of the horizontal return tubular type that are recorded in the Police Department of New York City as unknown, and have uptake doors in them that are as tight as any new boiler.

The reason for this is, in my estimation, that I never let my firemen clean the soot from the doors, thereby keeping them well insulated from heat which is sure to take the life out of them after years of heating and intermediate periods of cooling off.

Real logic backs up my contention and I am as proud of having nearly ½ in. thickness all over the inside of my doors which I also claim are saving me coal. This may be no remedy to Receiver or C. H. W., but may help somebody else in their predicament.

H. L. C.

THE BUREAU OF FOREIGN AND DOMESTIC COMMERCE of the Department of Commerce, Washington, D. C., wishes bound catalogs, or substantial unbound catalogs, on the following subjects. Folders, circulars and the like cannot be used: All kinds of machinery, including engines, boilers, pumps, gas producers and all auxiliary machinery and apparatus used in power generation. This is for reference in the work of the Bureau.

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PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH

BY THE TECHNICAL PUBLISHING CO.

537 South Dearborn Street,
CHICAGO, ILL.

New York Office, 150 Nassau St.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Copyright, 1917, by Technical Publishing Co.

Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.

Circulation of this issue, 22,000.

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Limiting Production in Wartime

England has found it necessary to do away with many restrictions upon labor for the period of the war, such as, the limitation of output—of employing unskilled labor for elementary work—of the use of woman labor and the stoppage of work by strikes. In all cases the government has pledged itself to see that the owner of a plant shall not profit by these changes unless the workman also benefits to like degree; and after the war, the former restrictions are to be restored unless other conditions are mutually agreed upon by owners and workmen.

In this country, we have not been long enough in the war to realize the effort that must be put forth if we are to win. Owners who in many cases have been making large profits from wartime contracts for other nations have not yet realized that in the struggle which has now become our own, their self-interest lies with yielding personal gain in order to help the nation. It is natural, therefore, that the workmen's representatives should be asking for limitation of working hours and for increase of pay so that they may share in the gains from war conditions.

But it is essential that all should realize that, in order to succeed in our great undertaking, everybody must be willing, even eager, to do all that he can to help. Workmen must have wages that will make possible comfortable living and working hours that will avoid exhaustion. Owners must have return on investment that will make it worth while to continue in business. But efforts to secure an unwarranted return for labor or capital, or to increase leisure, strike at the fundamental present needs of the country. If we are to end the war favorably in the shortest possible time, and thus at the least cost to us of money and lives, each one must think not of gain or comfort, but of service.

For the period of the war, the duty of every loyal citizen of the United States is to seek how he may best further the success of the war. Sacrifice of profits, saving and loaning to the government, husbanding of food and fuel, helping to increase food supply, working harder and longer at our regular job—all these we can and should do.

The effort of some lawmakers to push bills limiting hours and output is certainly not in line with our needs and is unhelpful.

In order to get the fighting forces that we must have, a multitude of workers are being withdrawn from industry. Yet our need for industrial activity was never so great as now. These men must have arms, ammunition and equipment. They must be fed and transported. They must have artillery, airplanes, ships, clothing, food, even comforts, that they may effectively fight our battle against world conquest.

These needs, and the regular requirements of our living, can be met only by increased activity of those who are behind the lines. And any decreasing of activity by cutting off reasonable returns on invested capital, by refusing adequate compensation to workers, by seeking unwarranted profits because of the needs of the nation or the people or by reducing hours of labor in order to add to leisure is a disservice to our country and to ourselves in this time of great crisis.

Loyalty demands that we stand squarely behind Uncle Sam in thought, word and deed, avoiding all speech and action that can hinder his success, and disparaging such speech and action in others.

Insuring Continuity of Service

Station equipment so frequently found suffering from lack of proper care and attention is the electric switching and control apparatus which though considered by some operators as of secondary importance, is as instrumental in providing continuous service as are the prime movers. Whether or not switch and control boards and panels have their networks of wiring entirely exposed, partially enclosed or wholly enclosed, more or less dust and dirt often combined with oil will settle around and between the many conductors, rendering the wiring insulation subject to breakdown, especially in the case of the higher voltage lines. Access to these parts is many times quite difficult or even impossible, due to various causes, such as lack of room, and continuous operation conditions which make it practically impossible for anyone to inspect, clean and repair the maze of wiring and apparatus carried at the rear of the modern switchboard. It would appear, therefore, desirable, in the case of new plants which when once placed into service are to be in continuous operation, to install some form of board built up of removable panels, by means of which the control equipment of a generator or a distribution circuit may be separated from the rest of the board, thereby allowing necessary cleaning and repairs to be more readily accomplished.

Should the adoption of this arrangement not prove feasible or desirable, the wiring of the boards might be so sectionalized and arranged that parts of it may be cut out entirely so as in no way to interfere with the service rendered by the plant. A scheme of this sort may call for a design somewhat different from that generally employed, but it would appear as if the extra cost involved might be many times offset by the insurance thus offered against interruption of service and damage to equipment.

The majority of switchboards, even those carrying currents at the lower voltages, are today provided with oil break switches and circuit breakers. These also should be given periodic attention, the oil replaced by fresh, the tanks thoroughly cleaned and the switch clips thoroughly inspected for loose and burned contacts. If this damage is of but a minor nature, the members may again be put into first-class condition by the correct application of a fine cut file to the burned part; but if, as is many times the case, a considerable portion of the blade or clip has been burned away, new ones should at once be provided.

All electrical measuring instruments found on the fronts of control or switchboards are, due to the delicate form of construction employed, and the vibration encountered in most power plants, very subject to being thrown out of adjustment. It is, therefore, advisable and desirable to check up these meters at least once a month by means of standards which should be provided for the purpose.

In small plants the equipment required would not necessarily be very extensive and the checking of the instruments might be left to one of the operators. But in the larger stations, those of 10,000 kw. capacity and more, the number of standards necessary and the time required to check and re-calibrate the switchboard instruments is such as to warrant incorporating this branch of the organization with the regular testing laboratory.

Do You Know

Just what kind of an arrangement is employed on the Allis-Chalmers pumping engines to regulate the speed when these units feed direct into the distribution mains? Draw a rough sketch and satisfy yourself that you understand this mechanism thoroughly.

What formula to employ to determine the efficiency of a ligament between the tube holes of a Stirling boiler?

The approved manner in which to place a Stirling or other boiler into service?

The effect of free oxygen and carbonic acid in hot water supply lines? How may this trouble be eliminated?

The two general principles upon which oil feeding as employed in connection with boiler furnaces is based?

How you may judge the temperature of a flame?

In his article, Oil and Powdered Coal as Fuel, Mr. Harrington presents some data relative to the comparative fuel purchasing power of one cent. Considered from the viewpoint of operation only, which would be the most economical for you to employ in your plant, fuel oil, gas, or powdered coal?

Instruments for the analysis of fuel, water, flue gases, etc., and standards for the checking up of the various measuring and metering devices employed in a power plant, are as essential to efficient operation as the pressure gages on your boilers and the voltmeters, the ammeters, and the watthour meters on your switchboard. How complete is your equipment along this line?

In the analysis of flue gases, what operating factors are to be given particular attention in order to obtain results actually representative of the conditions to be tested?

If it is desired to check up on the combustion in the furnace, from what point should the sample be taken, and where and how should the sampling tube or pipe be placed?

Boiler cleaning at best is a very disagreeable job, but one which must be done and thoroughly at that. Do you, or do you allow your men, to rush through with this work regardless of the manner in which it is done, or do you insist that the deposited scale shall be removed from all parts of the shell and the tubes, and thereby insure longer life and safe and efficient operation of your boilers?

In what way can G. R. eliminate the rattle in his lightly loaded Corliss engine? Think it over—send us your opinion on the subject. If at any time you have had similar trouble which you successfully overcame, let us hear from you.

Have you gone carefully and thoroughly through each section, each page and each article appearing in this issue and in such a manner that you feel satisfied that you have added at least something to your fund of knowledge? If so, don't place this copy on the shelf, there only to collect dust and dirt—pass it on to some friend, your assistant engineer, your oiler or your fireman. He'll be glad to get it and you'll be doing him a mighty good turn.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Farnsworth Tilting Steam Traps

THE Farnsworth duplex boiler feeder has two chambers which alternately fill and empty, and this process operates the control valve in the tilting of the machine. One heavy specially designed valve is used to control the steam into a machine. While steam is passing through the valve to one chamber which is passing the water into the boiler the opposite chamber is being vented through the same valve which permits the water to flow into the receiving chamber. After the water is emptied into the boiler and the receiving chambers are filled, the tank tilts, interchanging the valve which applies the steam to the opposite chamber, and fills the chamber that was formerly under pressure.

The continued operation of this receiving and filling makes it possible to have a continuous flow of condensation from the heated apparatus direct into the boiler, the principal advantage being that the apparatus is a receiving tank in itself and handles very high as easily as low temperature condensation. It makes no difference what the pressure on the boiler is when the steam is applied to the chambers. The equalized condition permits the water to flow into the boiler by gravity.

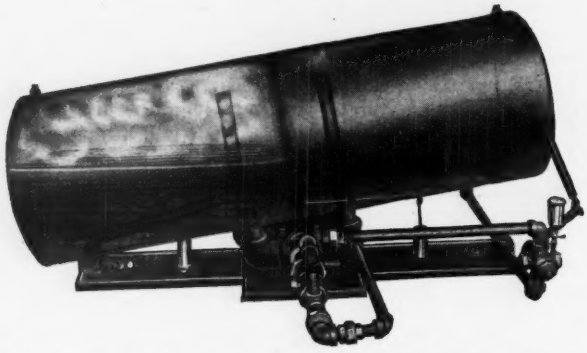


FIG. 1. PHANTOM VIEW OF THE FARNSWORTH DUPLEX BOILER FEEDER

This duplex boiler feeder is known as a master trap; it receives condensation from all high or low-pressure traps and feeds it direct to the boiler. To keep condensation under pressure from heated apparatus, steam lines, steam traps, etc., until it is fed to the boiler, is the one great problem for the temperature remains high.

In some installations there are as many as 50 high-pressure traps discharging back to this duplex boiler feeder. It is really a receiving tank, pump, and pump governor to apply the steam direct on top of the water instead of behind a piston in a pump to feed water into the boiler under the most efficient method as one cubic foot of steam displaces one cubic foot of water. For instance, pumping traps collect condensation at very low pressures and discharge it by the use of the high-pressure steam connection direct to the boiler feeder, no matter how high the boiler feeder may be above the pumping trap or above the low-pressure condensation.

The condenser pumping trap shown in Fig. 2 is provided with cold water jet sprays which create a vacuum, pulling the low-pressure condensation into the machine, and as the tank is filled it tilts down, opens the valve, applies the high-pressure steam and pumps the low-pressure condensation out. When the tank tilts up again it opens cold water valve which leads to a cold water spray in the top of the tank which condenses all steam that remains in the tank creating a high vacuum which pulls the low-pressure condensation into the tank.

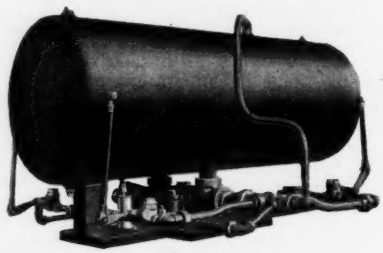


FIG. 2. CONDENSER PUMPING TRAP

This machine is especially desirable for pulling condensation from hot water tanks or from blast coils where cold air has passed over the coils and a vacuum created which tends to hold the condensation in the coils.

The variable-pressure trap is especially designed for handling condensation where the pressure is about to change instantly and with a desire to have the condensation pumped to a high point where the head pressure on the discharge line would be greater than an incoming condensation.

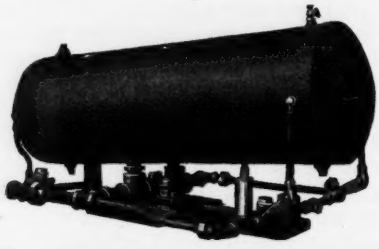


FIG. 3. FARNSWORTH VARIABLE PRESSURE TRAP

A high-pressure steam connection with a control valve is attached to the trap, and as the tanks fill and tilt down, opening the high-pressure valve which pumps the low-pressure condensation out, the low-pressure incoming condensation might change to high-pressure instantly. Having a valve on the outlet, the trap auto-

matically becomes a separating trap and the high-pressure steam is not required to pump the water to its destination.

These traps are particularly desirable for draining an apparatus where exhaust steam is used through the day and possibly live steam in the night where pressure is apt to build up, or where there are paper mills or dry kilns where high-pressure steam is constantly used and when the steam is shut down and low pressure admitted to keep the apparatus and coils warm.

The separating trap is particularly desirable for handling high or low temperature condensation and will discharge itself to any point where the pressure on the discharge line is less than the incoming condensation.

It is particularly designed for handling large lots of condensation, the valve being full area, and when the tank tilts down full of water and opens the valve, the valve will remain open until the lines or apparatus are entirely free of condensation. It has a water seal which prevents any steam from getting through the trap.

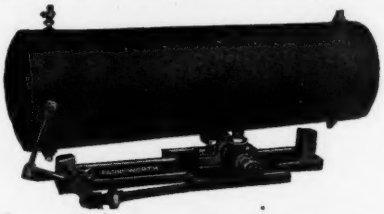


FIG. 4. NONRETURN OR SEPARATING TRAP

These traps are built by the Farnsworth Mfg. Co. of Conshohocken, Pa., with extra heavy tanks, fittings, valves, etc., and the valve is of Monel metal seat and disc on all machines where a pressure is over 125 lb. All tanks are carried on a steel shaft in a babbit metal bearing which eliminates all load from the swing joints. The swing joints are of the Tuxedo type, made by the Franklin Williams Co.

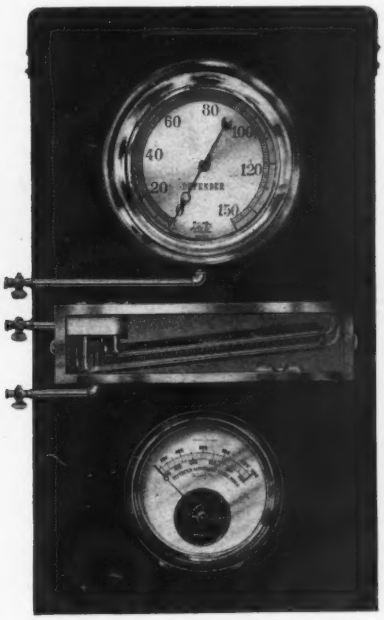
Each machine is supplied with a graphite lubricator cup to keep the valve and joints well lubricated. All the larger size machines are equipped with oil cushion dashpots to relieve any jar in the operation; the tank is carried on a steel shaft; friction is reduced to a minimum which gives very positive operation.

Defender Control Boards for Boiler Fronts

ECONOMICAL and successful operation of boiler plants may be realized only when means are provided whereby it is possible for the operators to determine with a minimum of effort the actual performance of the various steam generating units. Various schemes have been introduced to bring about the results desired; but as in the majority of instances the instruments employed have generally been scattered about the boiler room, some even in inaccessible places, thus requiring considerably more time and attention for their proper manipulation than the attendants would or could give them, they are soon neglected and then discarded. The most logical arrangement, and one now generally adopted in most modern plants, consists of grouping all of the instruments and mounting them on a central control panel or board so placed as to be continually in plain view of the operators. Naturally, they are given more attention and tend to create greater interest on the part of the firemen, between whom a friendly rivalry will exist as to which one may be able to maintain the best record of boiler performance.

In order to meet the rapidly growing demand for such equipment, the Defender Automatic Regulator Co., of St. Louis, Mo., has devised and recently placed upon the market what is known as the Defender Control Board for fronts of boilers, one of which is shown in the accompanying illustration.

Essentially these boards consist of a backing of stove iron castings covered with two coats of black enamel which may be set on the front corner of the boiler, the side of the boiler, the wall in front of the boilers or, if so desired, may be mounted upon the supporting columns alongside of the boilers. Or two short lengths of 1½-in. extra-heavy pipe resting on a pier of brick or concrete may be employed for the purpose. With this arrangement, or wherever the board may be set some distance



DEFENDER CONTROL BOARD FOR BOILER FRONTS

from the supporting wall allowing the pet cocks to be handled from the rear, the gages are furnished with back connection, an arrangement quite desirable in many installations.

Attached to the top of the board is a shelf bolted to the sides. This shelf, which has cast within it an opening for the reception of an electric lamp whereby the board may be properly illuminated, projects about 8 in. to the front and is flat on top, at which point a steam flow meter may be mounted if so desired. It is dustproof and prevents dirt, moisture or soot from falling on the instruments below.

The equipment regularly mounted on these boards consists of one 8½-in. Defender steam pressure gage with extra heavy bronze spring and movement; one left-hand connected Defender differential draft gage; and one 6-in. Defender electric pyrometer for reading the flue gas temperature. If, however, so desired, or local

conditions require, other Defender instruments may be added or substituted, although the removal of the steam gage is not recommended as this being brought down to a level convenient to the fireman's view a smaller and lower reading gage may be employed than when these instruments are mounted on the boiler fronts.

One form of these control boards is fitted with cast-iron doors, having heavy flat glass fronts.

The Turner Boiler Baffle Wall

BOILER baffles are one of the most difficult details to maintain in boiler room practice. This is especially true of the horizontal water tube type with vertical baffles. The Turner wall, which has met with considerable success for this purpose, is composed of fire brick laid as diagonal shelves on the boiler tubes; the pockets formed by the tubes and the tile being completely filled with a fire resisting cement in a plastic condition.

The plastic cement, in setting, shrinks away from the tubes so that a cold tube may easily be pulled out and renewed without injuring the wall. The expansion of the tube when hot closes this space and makes the wall tight. In case of accident, the wall may be easily repaired and tube renewals are simplified. If a bent tube is encountered, it is a simple matter to enlarge the hole in the wall to permit the new straight tube to be put in its proper place. As there are no loose tile to drop out of place, the enlargement of the hole may readily be pointed up by the boiler room force.

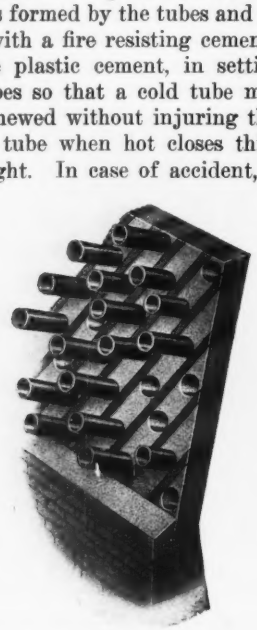
Turner baffles can be built with or without iron flame plates and can be laid at any angle to the tubes. This is especially desirable when remodeling boiler settings where the bridge wall is carried back to accommodate stokers or larger grates, as the baffle can be made to form tapered first and second passes and allow the rear baffle to be carried down much lower than usual. With passages of this sort, the heat is distributed throughout the boiler in the most efficient manner and low stack temperatures are secured.

Turner walls can be installed without injury to the boiler or to the setting and have been in use for 4 yr., it is claimed, without signs of deterioration, even when subjected to the intense heat of stoker fired boilers, showing great durability and permanence. Turner walls are the product of the Engineer Company, New York City.

Fisher Automatic Air Trap

AIR tending to accumulate in hot water mains, pipe lines and in closed water receivers or tanks may be positively and automatically released by means of Fisher automatic air traps. These traps, which are manufactured by The Fisher Governor Co., of Marshalltown, Iowa, may be installed in practically any pipe line, and if properly placed will release all air and close tightly against the liquid; by being equipped with whistles they may also be made to serve as low water alarms on closed tanks or reservoirs.

The absence of complicated working parts and simplicity of construction may be noted by reference to the accompanying illustrations. Contained within the cast-iron body is a large high-pressure, seamless copper ball float, which through the medium of a short lever attached thereto operates the air valve placed in the cover of the trap. Valves and nozzles can be furnished for operation under any pressure desired and may be renewed at any time without disturbing the pipe connections.



SECTION OF TURNER BOILER BAFFLE WALL

FIG. 1. FISHER TYPE NO. 30 AUTOMATIC AIR TRAP

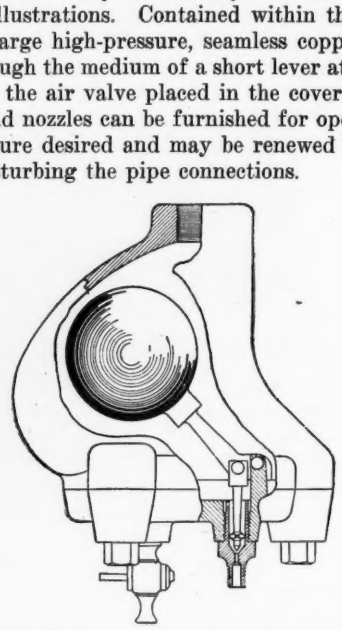


FIG. 2. SECTIONAL VIEW OF FISHER TYPE NO. 30 AUTOMATIC AIR TRAP

Being but 7½ in. in height, these traps occupy but little space; they are self-contained and have no outside adjustments which may be tampered with.

An additional air vent on the cover plate allows inspection of the trap, while in service.

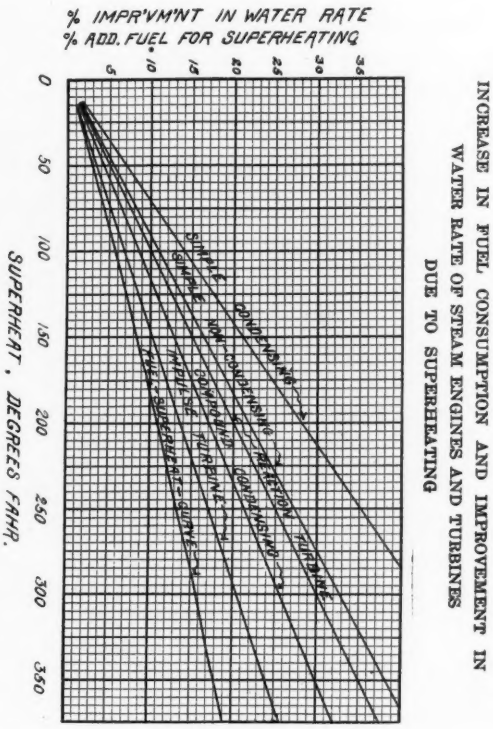
The inlet, which is at the lower end of the body, is tapped for ¾-in. pipe; the outlet is at the top.

ELECTRIC CURRENT is transmitted at 150,000 volts over a distance of 240 miles from hydroelectric stations in the Sierras to Los Angeles.

THREE hundred and sixty million people in the eastern countries use this in place of wheat flour as a staple food. At 3 c. a pound, it has a greater value than wheat flour at 5 c. With proper attention, it is a more certain crop than either wheat or corn. Dining cars and restaurants have long used it for griddle cakes and waffles, but it is well suited for other uses. For muffins, use 2 cups kafir meal, 2 teaspoons sugar, 1 teaspoon salt, ½ cup water, ½ cup wheat flour, 2 teaspoons baking powder, 1 cup milk. Keep the batter thin.

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

POWER PLANT ENGINEERING


% IMPR'VM'NT IN WATER RATE
% ADD. FUEL FOR SUPERHEATING
SUPERHEAT, DEGREES FAHR.
SIMPLE NON-CONDENSING
SIMPLE CONDENSING
COMPOUND NON-CONDENSING
COMPOUND CONDENSING
STEAM TURBINE
INCREASE IN FUEL CONSUMPTION AND IMPROVEMENT IN WATER RATE OF STEAM ENGINES AND TURBINES DUE TO SUPERHEATING

POWER PLANT ENGINEERING

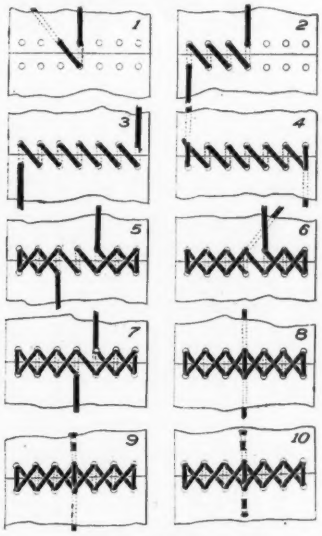
COMPOSITION OF BRONZES

	Parts.
White Metal:	
Tin	7.6
Copper	2.3
Zinc	83.3
Antimony	3.8
Lead	3.0
Hard Bronze for Piston Rings:	
Tin	22.0
Copper	78.0
Bearings—Wearing Surfaces, etc.:	
Copper	6
Tin	1
Zinc	¼
Naval Brass:	
Copper	62.0
Tin	1.0
Zinc	37.0
Brazing Metal:	
Copper	85.0
Zinc	15.0
Anti-friction Metal:	
Copper—(best refined)	3.7
Banca tin	88.8
Regulus of antimony	7.5
Well fluxed with borax and rosin in mixing.	
Bearing Metal—(Pennsylvania Railroad):	
Copper	77.0
Tin	8.0
Lead	15.0

MACHINERY'S REFERENCE SERIES

POWER PLANT ENGINEERING

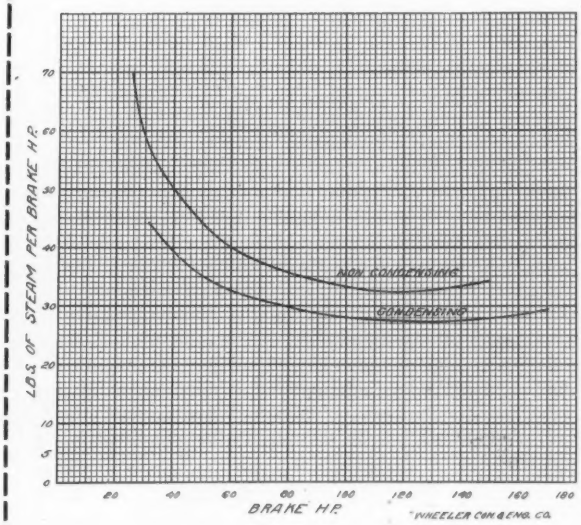
LACING BELT BY STANDARD METHOD IN MOST GENERAL USE

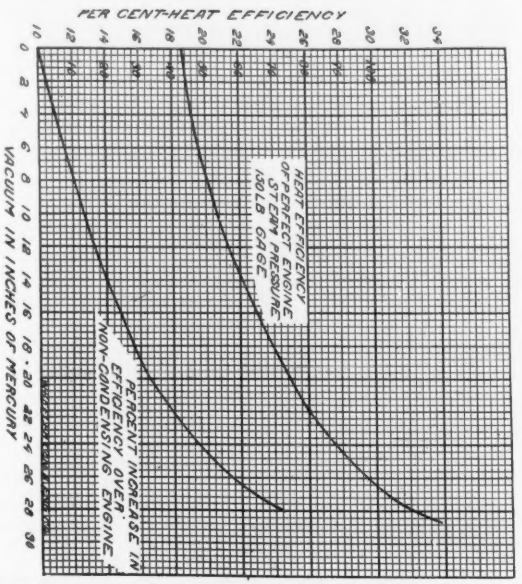


CHAS. A. SCHIEREN CO.

POWER PLANT ENGINEERING

EFFECT OF VACUUM ON STEAM CONSUMPTION OF A SIMPLE SLIDE VALVE ENGINE




PER CENT-HEAT EFFICIENCY
VACUUM IN INCHES OF MERCURY
HEAT EFFICIENCY OF PERFECT ENGINE WITH STEAM PRESSURE 100 LB GAGE
PER CENT INCREASE IN EFFICIENCY OVER NON-CONDENSING ENGINE

EFFICIENCY OF THE PERFECT ENGINE

COMPOSITION OF BEARING METALS

Alloys.	Lead.	Tin.	Anti-mony.	Cop-per.	Zinc.	Other Con-stituents.
Babbitt 1	80.00	20.0	.....	.....	.....	.....
Babbitt 2	72.0	21.0	7.0	.....	.....	.....
Babbitt 3	70.0	10.0	20.0	.....	.....	.....
Babbitt 4	80.5	11.5	7.5	0.5	.....	.....
Babbitt 5	0.5	68.0	.....	1.0	31.5	.....
Babbitt 6	....	20.0	.....	.....	80.0	.....
Babbitt 7	.....	86.0	10.0	4.0	.....	.....
White metal	82.0	.....	12.0	6.0	.....	.....
White Brass	..	64 0	.....	2.00	34.0	.....
Magnolia metal	80.00	4.75	15.0	trace		$Bi = 0.25$
Car brass lining	80.5	11.5	7.5	0.5	.....	.....
Ajax plastic bronze	80.0	5.0	.....	65.0	.....	.....
Ajax metal	11.5	11.5	.....	77.0	.....	.....
P. R. R. car brass, B	15.0	8.0	.....	77.0	.....	$P = 0.80$
S bearing metal	9 5	10.0	....	79.7	.....	.....
Delta metal	5.1	2.4	.....	92.4	.	$Fe = 0.1$
Camelia metal	14.8	4.8	.....	70.2	10.2	$Fe = 0.5$
Tempered lead	98.5	0.08	. ....	0.11	.....	$Na = 1.30$

Bi = bismuth; P = phosphorus; Fe = iron; Na = sodium.

MACHINERY'S REFERENCE SERIES

SIZES OF LACES FOR LEATHER BELTING

Width of Belt	Width of Lace to Use	Length of Lace to Use	Number of Holes	Use Round Punch No.	Showing Exact Size of Hole
1-1/2 in.	1/4 in.	15 in.	3	6	
2 in.	5/16 in.	24 in.	3	6	
2-1/2 in.	5/16 in.	2-1/2 ft.	3	6	No. 6
3 and 3-1/2 in	5/16 in.	3 ft.	5	6	
4 in.	3/8 in.	3-1/2 ft.	5	8	
4-1/2 and 5 in.	3/8 in.	4 ft.	5	8	No. 8
5-1/2 and 6 in.	3/8 in.	4-1-2 ft.	7	8	
6-1/2 and 7 in.	7/16 in.	5 ft.	7	8	No. 10
8 in.	7/16 or 1/2 in.	5-1/2 ft.	9	8	
10 in.	1/2 in.	6 ft.	9	10	
12 in.	1/2 or 5/8 in.	6-1/2 ft.	11	10 or 12	No. 12

CHAS. A. SCHIEREN CO.

MEAN SPECIFIC HEAT OF SUPERHEATED STEAM

Gauge Pressure	Degree of Superheat																	
	50	60	70	80	90	100	110	120	130	140	150	160	170	180	190	200	225	250
50	.518	.517	.514	.513	.511	.510	.508	.507	.505	.504	.503	502	.501	.500	.500	.499	.497	.496
60	.528	.525	.523	.521	.519	.517	.515	.513	.512	.511	.509	.508	.507	.506	.504	.504	.502	.500
70	.536	.534	.531	.529	.527	.524	.522	.520	.518	.516	.515	.513	.512	.511	.510	.509	.506	.504
80	.544	.542	.539	.535	.532	.530	.528	.526	.524	.522	.520	.518	.516	.515	.514	.513	.511	.508
90	.553	.550	.546	.543	.539	.536	.534	.532	.529	.527	.525	.523	.521	.519	.518	.517	.514	.510
100	.562	.557	.553	.549	.544	.542	.539	.536	.533	.531	.529	.527	.525	.523	.522	.521	.517	.513
110	.570	.565	.560	.556	.552	.548	.545	.542	.539	.536	.534	.532	.529	.528	.526	.525	.520	.517
120	.578	.573	.567	.561	.557	.554	.550	.546	.543	.540	.537	.535	.533	.531	.529	.528	.523	.519
130	.586	.580	.574	.569	.564	.560	.555	.552	.548	.545	.542	.539	.537	.535	.533	.531	.527	.523
140	.594	.588	.581	.575	.570	.565	.561	.557	.553	.550	.547	.544	.541	.539	.536	.534	.530	.526
150	.604	.595	.587	.581	.576	.570	.566	.561	.557	.554	.550	.547	.544	.542	.539	.537	.533	.529
160	.612	.603	.596	.589	.582	.576	.571	.566	.562	.558	.554	.551	.548	.545	.543	.541	.536	.531
170	.620	.612	.603	.595	.588	.582	.576	.571	.566	.562	.558	.555	.552	.549	.546	.544	.538	.533
180	.628	.618	.610	.601	.593	.587	.581	.575	.570	.566	.561	.558	.555	.552	.549	.546	.540	.536
190	.638	.627	.617	.608	.599	.592	.585	.579	.574	.569	.565	.562	.558	.555	.552	.549	.543	.538
200	.648	.635	.624	.614	.605	.597	.590	.584	.578	.574	.569	.566	.562	.558	.555	.552	.546	.541
210	.656	.643	.631	.620	.611	.602	.595	.588	.583	.578	.573	.569	.565	.561	.558	.555	.549	.543
220	.664	.650	.637	.626	.616	.607	.600	.592	.586	.581	.577	.572	.568	.564	.561	.558	.551	.545
230	.672	.658	.644	.633	.622	.613	.605	.597	.591	.585	.580	.575	.572	.567	.564	.561	.554	.548
240	.684	.668	.653	.640	.629	.619	.610	.602	.595	.589	.584	.579	.575	.571	.567	.564	.556	.550
250	.692	.675	.659	.645	.633	.623	.614	.606	.599	.593	.587	.582	.577	.574	.570	.567	.559	.553

Calculated from Marks and Davis Tables By the Babcock & Wilcox Co.

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News Notes

F. J. MILLER, recently of Miller-Combes Co., and previous to that with Thos. P. Ford Co., has been appointed assistant manager for Kieley & Mueller, Inc., 34 West 13th St., New York.

THE 12TH ANNUAL CONVENTION of the Smoke Prevention Association will be held in the Deshler Hotel, Columbus, Ohio, Sept. 25 to 27. Interesting papers by prominent engineers will be presented on the subject of smoke abatement.

REFERRING to the statement which has appeared to the effect that Johann Stumpf, of Germany, has been awarded a verdict over the A. Schreiber Brewing Co. for infringement, consisting of a Universal Unaflow engine in the brewing company's possession, we wish to state that such information without a statement from this company, who are the builders of the Universal Unaflow engine, would have the effect of creating a false impression.

This decision is not necessarily final, and an appeal will probably be taken in due course of time. The Skinner Engine Co. has not been sued, and will protect all present owners of Universal Unaflow engines and all future purchasers of Universal Unaflow engines in matters of this kind, and will continue to build the Universal Unaflow engine.

That this type of engine is the most economical for noncondensing work is substantiated by the fact that it is reported that the principal licensee of Johann Stumpf is now building noncondensing unaflow engines with auxiliary exhaust valves to lessen the clearance which would be required if the engines were built strictly in accordance with Stumpf patents.

The Universal Unaflow engine is manufactured under a number of patents owned by the Skinner Engine Co., and this company still believes that the final decision will show that its patents do not conflict with the Stumpf patents and, in the meantime, takes this means of informing present owners of these engines and future purchasers that they will be protected in case of any damage due to any alleged infringement.

SKINNER ENGINE CO.

THE SYRACUSE INDUSTRIAL GAS COMPANY, Syracuse, N. Y., announces that it has recently taken over the producer gas engine business of the Geo. D. Pohl Manufacturing Co., Vernon, N. Y., and is now in a position to manufacture these engines, which are of a heavy duty English design. This company is now prepared to put on the market a complete power plant instead of furnishing producers alone as they have done in the past 10 yr.

SEPT. 24, the Third National Exposition of Chemical Industries opens in the Grand Central Palace, New York City. Among the matters of interest to power plant engineers will be motion pictures illustrating the use of power in industries. Monday evening, Sept. 24, the subjects covered will be Hydraulic Power Development, Making a Giant Steam Turbine, Generation of Electric Power, Transmission of Electric Power, Fixation of Atmospheric Nitrogen by Electricity, Evolution of Transportation.

Tuesday afternoon: Manufacture of Carpets, Woolens, Cotton Goods, Leather and Glass. Tuesday evening: Mining, Smelting and Working of Lead and Zinc.

Wednesday afternoon: Manufacture of Paper, Cordage, Paint, Soap and Perfumes. Wednesday evening: Coal, Coke and Asphalt Industries.

Thursday evening: Silver and Gold Production.

Friday afternoon: Asbestos, Road Building, Sugar and Flour Industries.

Saturday afternoon: Cement Manufacture and The Milk Industry.

Addresses will be given on various chemical industries and meetings held of various Chemical Societies.

Catalog Notes

THE SEPTEMBER number of the Monthly Sales Service pamphlet published by The Society for Electrical Development, Inc., 29 W. 39th St., New York, was recently received.

KEEPING COOL IN EL PASO is the title of a booklet relating to Carrier air washers and cooling systems and "Buffalo" ventilating fans made by Carrier Air Conditioning Co. of America, Buffalo, N. Y.

CONSTRUCTION and advantages of the Riley self dumping underfeed stoker are discussed in an illustrated catalog from Sanford Riley Stoker Co., Ltd., Worcester, Mass.

Accompanying circulars relate to the following: Representative installations of Riley underfeed stokers; N. Y. Central R. R. Port Morris Station Riley stokers; new Niagara River power station, with 20 Riley stokers installed; the new rocker dump for Riley underfeed stokers.

SMALL CAPACITY industrial oil circuit breakers, Type FP-10, 30 amp., 600 v., for three-phase induction motors of 10 hp. or less, are described and illustrated in General Electric Bulletin No. 47,419, superseding No. 47,409.

FROM WALTER G. RUGGLES CO., Boston, Mass., we have received booklets on the following subjects: Triple duty automatic engine stops and safety shutoff valves; automatic damper regulator; automatic stop and check valves; automatic safety shutoff valves; reducing pressure regulators and exhaust outlet valves.

SAFETY-FIRST combined lever switches and fuses as described in Bulletin 47,380-A, which has just been issued by the General Electric Co., are destined to fulfil an important part in the present active campaign to safeguard life and property which is being carried on by such bodies as the Bureau of Standards, the National Board of Fire Underwriters, and by public service and safety commissions in several states.

The important features of the Safety-First enclosed lever switches, as contained in the bulletin are: Current-carrying parts are completely enclosed and inaccessible while alive; fuses are accessible only when they are "dead" and when the switch is in the "off" position; switches can be locked in the "off" position; the fuse chamber can be locked to prevent access by unauthor-

ized persons, without interfering with the operation of the switch.

Full information regarding construction and dimensions of the three types of switches will be found in this bulletin.

BETSON HI-HEAT CEMENT for mortar purposes for laying molded fire brick is described in a new circular from Betson Plastic Fire Brick Co., Rome, N. Y.

RELIANCE adjustable speed motors, armature shifting design, for direct current, are illustrated and described in Bulletin 1014 of Reliance Electric & Engineering Co., Cleveland, O.

COLUMBIAN ROPE CO., Auburn, N. Y., recently issued a 16-page booklet, Form A6, discussing the process of manufacturing Columbian cable.

MANZEL FORCE FEED OILERS for oiling the cylinders and bearings of oil, gas, gasoline, kerosene and other internal combustion or internal explosion engines, are described and illustrated in Catalog No. 27 of Manzel Brothers Co., Buffalo, N. Y.

BULLETINS FROM Defender Automatic Regulator Co., St. Louis, Mo., describe and illustrate Defender control boards, draft gages, electric pyrometers, flue gas thermometers, steam pressure gages, portable boiler room test outfits, Orsats, gas suction pumps, gas collectors and automatic damper regulators.

THE NATIONAL REGULATOR CO., of Chicago, has recently published two pamphlets, one entitled Metaphram Damper Regulators describes and illustrates regulators for high and low pressure steam boilers, hot water and vapor heating systems. The other describes National tank regulators for thermostatic control of hot water tank and industrial processes.

Trade Notes

THE ENGINEER COMPANY, of New York, is now the sole builder of the Turner Baffle Wall, which is rapidly acquiring favor with engineers, as its merits become more widely known. The B. W. R. Company, which formerly handled this wall, has retired from business and its President, J. W. Putnam, has become Manager of the Baffle Wall Department of the Engineer Company, and the entire plant and organization of the B. W. R. Company has been taken by the Engineer Company.

ORDERS for the complete motor equipment of the new plant of the Washington Pulp & Paper Co.'s new mill at Port Angeles, Washington, have been received by the Westinghouse Electric and Manufacturing Co., of East Pittsburgh, Pa. There are included a total of 42 motors with a total of 3380 hp.; two motor generator sets; two 2000-kv.a. transformers, 6600 to 2300-460 v.; three 300-kv.a. transformers, 2300 to 460 v. All motors of 50 hp. and above will be supplied at 2300 v. Synchronous motors will be provided with starting panels; these as well as the starting switches for induction motor will be equipped with ammeters and overload and no-voltage protection.

POWER PLANT ENGINEERING

Trade-mark, Reg. U. S. Pat. Off.

SEMI-MONTHLY

PUBLISHED ON THE FIRST AND FIFTEENTH OF EACH MONTH

Subscription price in advance in the United States, Mexico or united possessions, $1.00 a year.

In Canada, subscription price, $1.75 a year.

Foreign Countries, subscription price, $2.50 a year.

Address all letters and make all checks and money orders payable to Technical Publishing Co., 537 S. Dearborn St., Chicago, Ill.

Any advertiser is invited to examine our paid subscription lists and Post Office mailing receipts at any time.

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Full page, one year, each insertion, $66.00.

Half page, one year, each insertion, $38.50.

Quarter page, one year, each insertion, $22.00.

Eighth page, one year, each insertion, $13.25.

Front cover, $175.00 per issue.

Other specified positions, regular rate plus 10 to 50 per cent.

Stippled plates used, but no heavy, black and white plates.

Classified Rates

Per line, 30 cents each insertion.

Advertisements in this section are inserted under regular headings.

No display type allowed, but the first three words may be set in capital letters.

About nine words make a line. Minimum space sold, two lines.

Under classification "Position Wanted," advertisements not exceeding four lines will be inserted once for subscribers free of charge.

All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,000.

Technical Publishing Co.

537 S. Dearborn Street

Chicago

Position Wanted

POSITION WANTED — By engineer; have Ohio engineers' and boiler inspectors' licenses. Experienced with absorption method of manufacturing gasoline. Good references. Address Box 481, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 9-1-2

POSITION WANTED—By a practical engineer with over 20 years' experience. Have I. C. S. diploma. Can furnish best of references. Prefer Illinois or Missouri. Address J. M. B. Shanks, Dixon, Mo. 9-1-2

POSITION WANTED—Chief Engineer or Master Mechanic of Light & Power Co., or Factory; 12 years' experience. Age 30. Married. Present salary $1,500. Good references. East and middle west preferred. Address Kurt Illig, P. O. Box 77, Tuxedo, N. Y. 9-1-2

POSITION WANTED—As engineer in small steam plant not over 125 hp., by young man. Steady and sober habits. More than 5 years' experience as engineer in grain elevator. Good mechanic. Address Box 123, Dixon, Ia. 8-1-4

POSITION WANTED—By steamfitter with 17 years' experience at the trade. Can furnish references as to habits and ability to handle men. I am 33 years old. Married. Address J. H. D., 669 Wunderlick St., Barberton, O. 9-1-2

POSITION WANTED—By thoroughly competent man with 11 years' experience as engineer and assistant superintendent in sugar factories in Cuba, Mexico and Louisiana. Good steamfitter and machine repairman. Have had charge of 10 steam boilers and 6 ammonia compressors as day and night engineer. Can speak English, Spanish and some German. Single. 26 years old. Can furnish good references. Address Box 480, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 9-1-2

POSITION WANTED—By young man, 23 years old, as fireman or oiler in ice or electric light plant in city of St. Louis. Have had one year's experience in firing and some experience in steam engineering. Address Leonard Ochs, 1536 Papin St., St. Louis, Mo. 9-1-2

POSITION WANTED—Young man wishes a position as oiler or assistant to the engineer in a plant in New York City. One year practical experience. Address A. Benora, 156 Willow St., Yonkers, N. Y. 9-1-2

POSITION WANTED—By young man as assistant engineer or assistant switchboard operator in plant in or near Newark, N. J., where there is a chance for advancement. Three years' practical experience. Address Wm. Wykes, 358 S. 7th St., Newark, N. J.

POSITION WANTED—By practical engineer of 15 years' experience. Am familiar with a.c. and d.c. generators and motors, also refrigerating machinery. Am 38 years old, married, and strictly sober. Good references. E. W. Jones, Genl. Del., Metropolis, Ill. 9-15-1

POSITION WANTED—Will represent some engineering firm in Mexico or take a position as chief engineer. Can operate electric, ice or power plant. Can speak, read and write Spanish. Am practical and progressive engineer. Will consider only well rated concern. Am colored. C. D. Bassett, Engineer, 183 N. Wabash Ave., Chicago, Ill. 9-15-1

POSITION WANTED—By young man as engineer in power plant. Seven years' experience in gas works and small central station operating. A-1 references. Present salary $1,300. Married. Age 25. Address Box 490, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 9-15-1

Help Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Cal.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Cal.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. tf.

WANTED—An engineer for electric light and power plant station of 3,000 kw. capacity, located in Pennsylvania. Address Box 488, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 9-1-2

WANTED—A designer of regulators and a designer of tools. None but thoroughly experienced men need apply. Good opening with big manufacturing company in the Middle West. Address Box 491, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 9-15-1

Wanted

WANTED—Agents on commission to sell our shaking grates. We will install grates on trial or put it to test at our expense with any grate made. Address Armstrong Mfg. Co., Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler room specialties in every section for side line paying large commissions. Give experience, line carried and territory covered. Box 381, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

WANTED—Marine boilers. We will pay cash awards for information that leads to a purchase by us of marine boilers of from 75 hp. to 250 hp. The Pittsburg Boiler & Machine Co., Pittsburg, Kan. tf

For Sale

FOR SALE—Ice and electric light plant in growing town in Southern Illinois. A. C. equipment. Long term franchise and street lighting contract. Railroad icing contracts and a good ice business otherwise. Plant all new. This is a good proposition for a live man. Address Box 489, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill. 9-1-2

FOR SALE—Slater Corliss engine, 150 hp., used two years; National feed water heater; Knowles double acting boiler feed pump, 3¼x3½x5; Stewart horizontal tubular boiler, 150 hp., 125 lbs. pressure; 24-in. single drum steam hoist with 300 ft. of ½-in. steel cable; Blake duplex steam pump, 4¼x4¼x5; B. F. Sturtevant engine connected 60-in. boiler with steam coils. S. Seiger, 22 Portland Pier, Portland, Me. 9-15-2

FOR SALE—Alternating current units: 75-kw. Allis-Chalmers, 60-cycle, 220 or 240-v. alternator, d.c. Ideal engine. Like new. Fully guaranteed. $1,800. 50-kv.a. Westinghouse belted alternator, as above, $500. Power Machinery Exchange, Jersey City, N. J.

Patent and Patent Attorneys

PATENTS THAT PROTECT AND PAY—Advice and books free. High references. Best results. Promptness assured. Send sketch or model for search. WATSON E. COLEMAN, Patent Lawyer, 624 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact costs. Send for full information. tf.

A. P. CONNOR, Consulting Electrical and Mechanical Engineer, Attorney-at-Law and Solicitor of Patents and Trade-Marks. Results guaranteed. 121 Carroll St., S. E., Washington, D. C. tf.

PATENTS—Send sketch for free search and reports. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Technical Books

FREE ENGINEER BOOKS and power plant tools and specialties, for securing new subscribers for Power Plant Engineering. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Subscription Department, Power Plant Engineering, 537 S. Dearborn St., Chicago, Ill.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes with back pressure on your engine? If so, address Monash Engineering Co., 1413 Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

Hopeless Minority

Ninety per cent of the advertisements printed in America are true and reliable.

Only ten per cent are false and misleading, and this ten per cent is gradually being won over to the side of the majority.

The profits of Truth are far greater than the profits of dishonesty.

We prophesied on this page, several years ago, that the unscrupulous advertiser who deceives the unsuspecting public would soon be a relic of the past. And now we can report on the firm basis of statistics that only ten per cent remain in the class of the deceptive.

And not a fraction of one per cent of this ten per cent hold space within the advertising section of POWER PLANT ENGINEERING.

This attitude towards unscrupulous advertisers has preserved a wholesome relationship with the legitimate advertiser and has given to the large family of buying-readers a feeling of absolute security.

Advertising has come into its own and with Business is building for Permanence on the solid foundation of Truth and Service. Inseparably, they stand foursquare to the world.

This poetic effusion from an unknown source expresses the setiment of Advertising and Business:

I come no more in grey disguise,
With grasping hands and greedy eyes,
Living on larceny and lies.
No longer do my mighty hosts
Of ministers and servants boast
Of giving least and getting most.
But now, with eyes greed cannot blind,
With open hands and willing mind,
I live in Service to mankind.
And hold him first among the rest
Who bears this motto on his breast:
He Profits Most Who Serveth Best.